VOL. 22, No. 7 JULY, 1945

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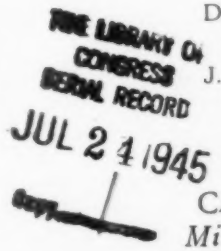

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Publication Office: 1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

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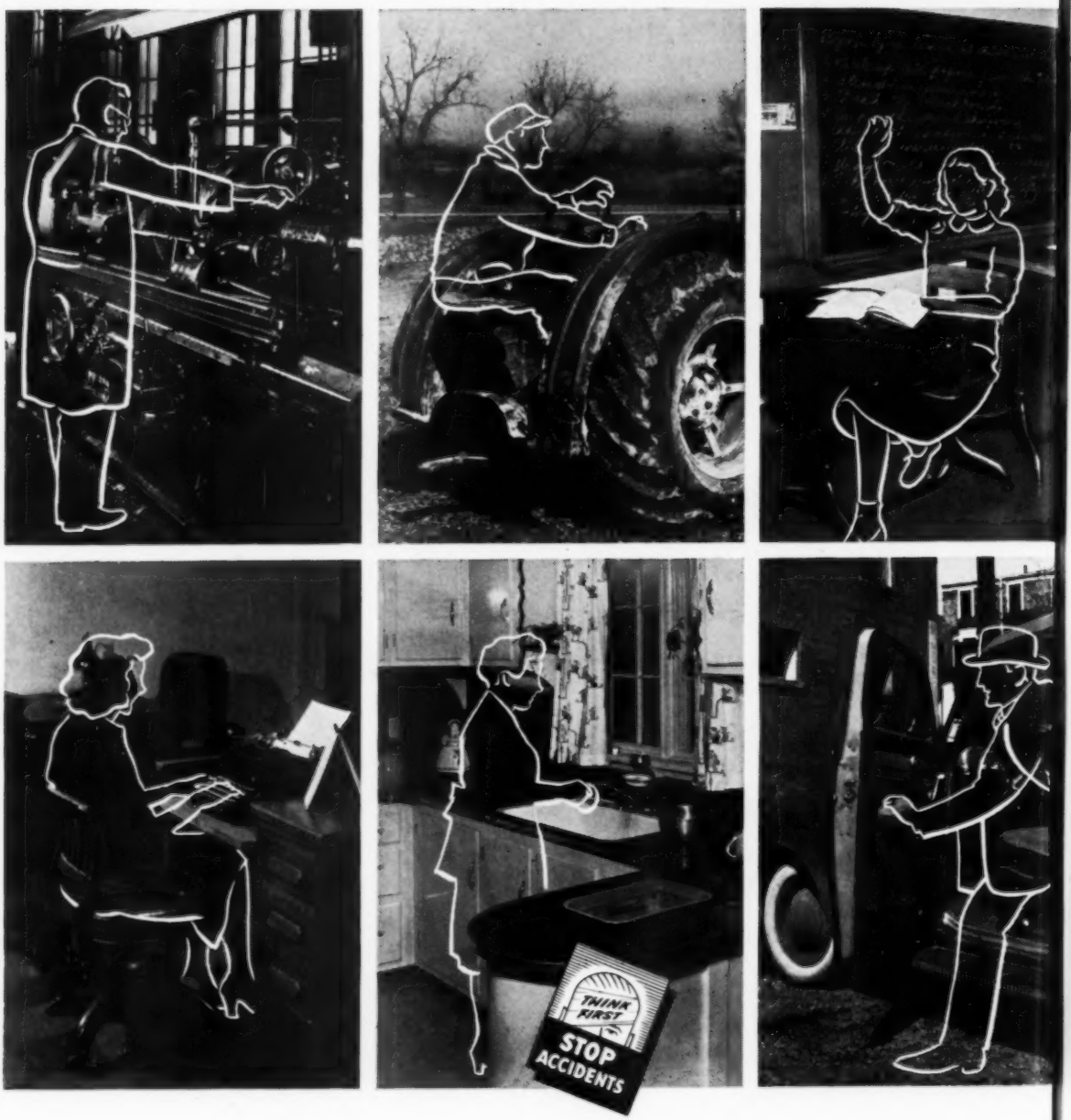

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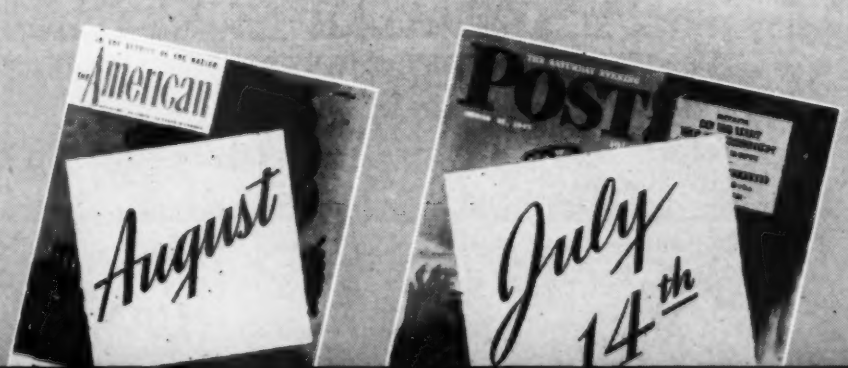

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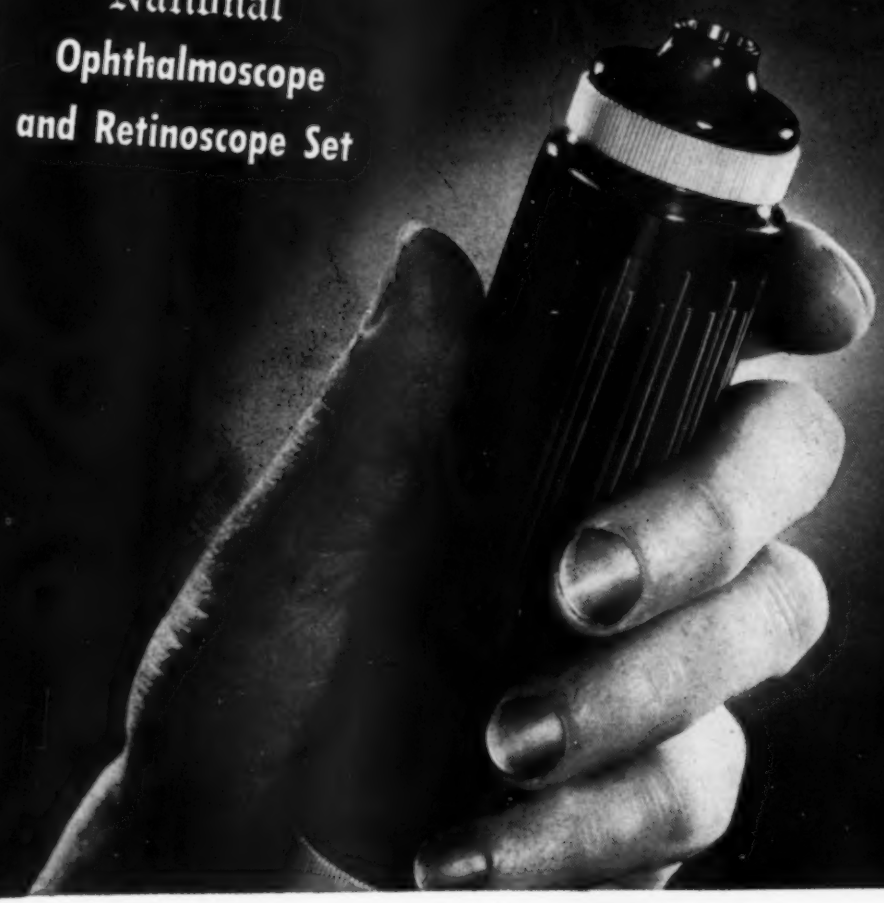

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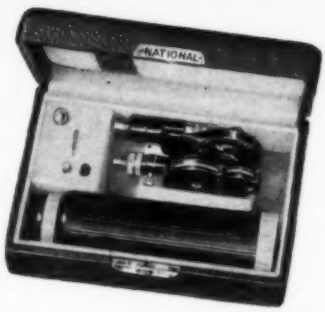

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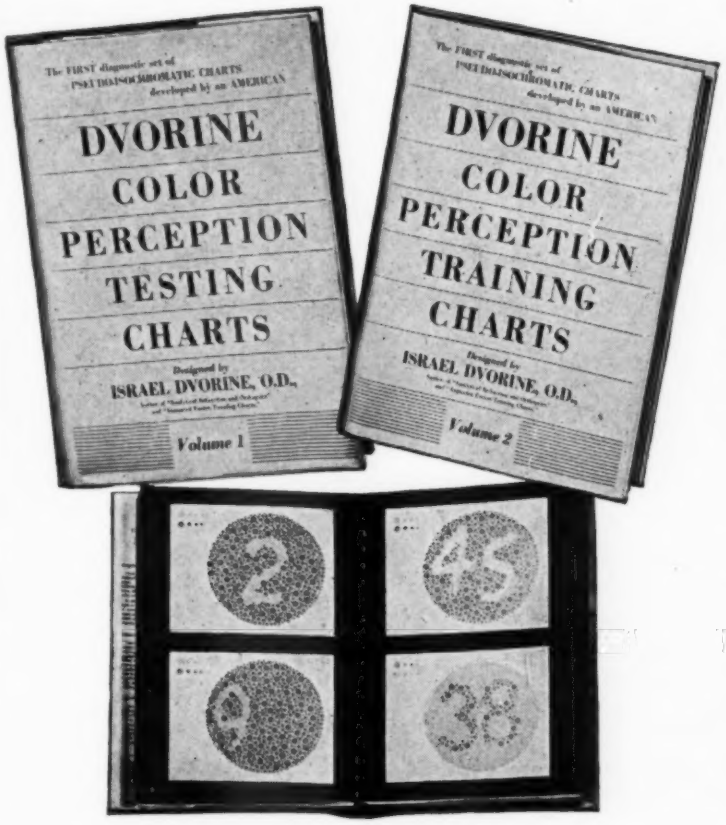

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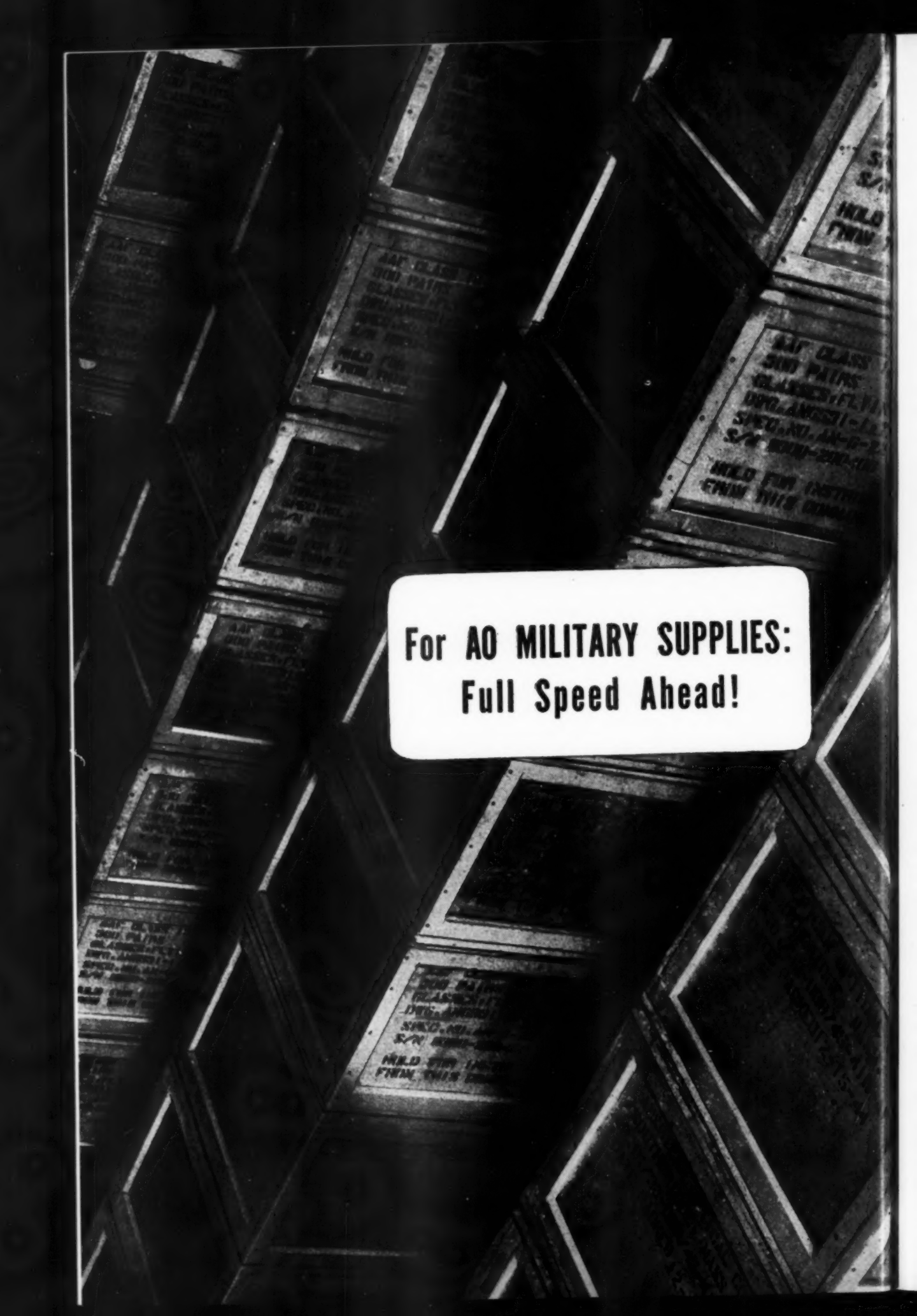
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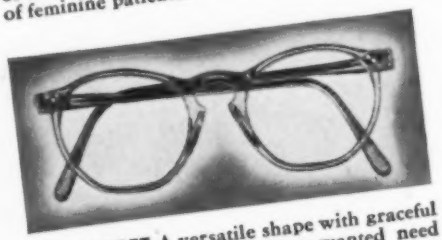

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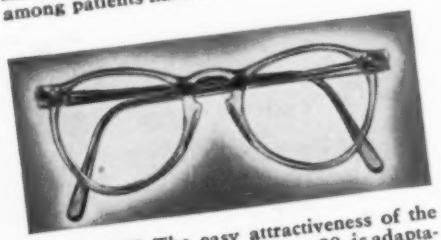

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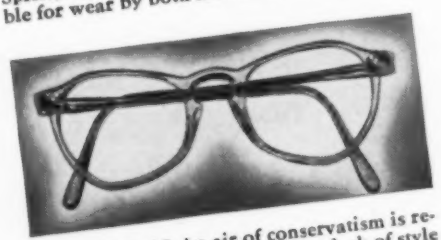

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Vol. 22 JULY, 1945 No. 7

THE ZONE OF CLEAR SINGLE BINOCULAR VISION*

H. W. Hofstetter
School of Optometry
Ohio State University

PART I

Introduction
History
Apparatus and Procedure

INTRODUCTION.

When a normal pair of eyes are made to fixate an object binocularly the object is seen singly and clearly. While this fixation is maintained it is possible to place a limited amount of base-in or base-out prism in front of one or both of the eyes without making the object appear blurred or doubled. Likewise a limited amount of plus or minus lens power placed equally before the two eyes permits single and clear vision.

If now the range of accommodation is measured for various amounts of convergence and the range of convergence is measured for various amounts of accommodation the limit of the ranges so obtained can be plotted on a system of coordinates. The data so plotted circumscribe a zone on the graph which may be called the zone of clear single binocular vision. The shape of this zone approximates a parallelogram. The fact that the zone has a finite width indicates a relative freedom of convergence from accommodation. The fact that the sides of the zone slope shows that the range of relative convergence shifts with changes in accommodation. This means of course that there is an interdependence between the two types of responses.

It is not out of order to emphasize the distinction between these two aspects of the relationship between accommodation and convergence.

---

* This is the first of two parts of a paper dealing with certain clinical aspects of binocular vision, presented to, and published on behalf of, the Distinguished Service Foundation of Optometry, for publication in the July, 1945, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

There is found in the literature for example such expressions as "loose relationship," "tight hook-up", and "play between the functions" which refer to the width of the zone. On the other hand such expressions as "weak" and "strong" relationship refer to the slope of the zone. An attempt has been made in this paper to avoid the use of the word relationship in any such specific sense. Wherever it occurs it is intended to refer only to the very general "state of affairs" that exists between the two functions.

The zone of clear single binocular vision has been measured by several investigators and by several techniques. The variety of results obtained has led to considerable confusion as to the true form of the normal zone and to the interpretations to be derived from them. It is therefore one of the purposes of this review to make a comparative survey of the results obtained in these investigations as a background for the report of the experimental investigations made by the writer.

HISTORY.

Probably the first recorded observation of the relationship existing between accommodation and convergence was made by William Porterfield[23] in 1759.† His observation was incidental to an experiment in which he showed that accommodation is effected by a change in focus, or, in his own words, "that the eye adapts itself to the distance of the objects seen." In doing the experiment monocularly he often found difficulty in accommodating accurately for the distance of the object, even though the object was within the range of clear vision. This difficulty was not present, however, when he employed both eyes. His interpretation was that the use of both eyes enabled him to judge more accurately the actual distance of a fixation object and so made it possible for him to accommodate more accurately. He believed that the judgment of distance was dependent upon the convergence of the eyes. Hence the relationship that he pointed out was that the convergence necessary for a given object distance acted as a guide for the proper amount of accommodation. He further added that this relationship had been learned through "use and custom".

According to Hess[10], the next observation on the relationship between accommodation and convergence was made by E. H. Weber[29] in 1821. Weber is said to have noted that he was able to fixate a distant object singly and at the same time see it clear or blurred as he desired. This, of course, indicated a certain amount of freedom between the two functions.

---

†References will appear at the end of Part II, August, 1945, issue.

The first objective demonstration of the relationship was made by Johannes Muller [18] in 1826 when he occluded one eye and showed that it converged with an increase in the stimulus to accommodation of the non-occluded eye. The stimulus to accommodation was controlled by the distance of the fixation object. He estimated the amount of convergence to be such that the occluded eye was always directed toward the object and he claimed to verify this by the absence of diplopia when the occluder was suddenly removed. He further observed that, although he could obtain either a diplopia or a blurring voluntarily within the limits of accommodation, the two phenomena always occurred simultaneously, i. e. when he voluntarily saw an object blurred, he at the same time saw it double, and when he voluntarily saw an object doubled, both of the images of the object were blurred. He attributed the intimate tie-up between the two functions to the partial origin of the ciliary nerve stem from the oculomotor nerve.

He noted an exception to this tie-up in the fact that he could still see an object singly when it was beyond his far point of accommodation (Muller was evidently a myope). He thus observed a freedom of association between accommodation and convergence only beyond the distant limit of accommodation.

In 1836 Volkmann[28] showed that the accommodation and convergence are separable even within the limits of clear vision. He demonstrated this by his ability to change, within limits, either the stimulus to convergence with prism lenses or the stimulus to accommodation with spherical lenses without inducing a blur or a diplopia. He then proposed the relationship to be only a *second grade* association which resulted from the normally synchronous use of the two functions over a long period of time.

To Donders[3] goes the credit for making the first experimental measurements of the limits of accommodation for given amounts of convergence and the limits of convergence for given amounts of accommodation. Donders employed an optometer which consisted of a pair of lens holders mounted at one end of a platform and a fixation target so mounted on the platform that it could be made to slide forward and backward along a line midway between the lens holders. Each of the lens holders was moveable in an arched groove whose center of curvature lay at the center of motion of the properly placed eye of the subject. The fixation target consisted either of vertical black lines on a white surface or a small circular bright spot on a black background. The choice of target varied

with different situations depending on which seemed more adequate in the given situation.

The determination of the far point of accommodation with no convergence was made by finding the maximum amount of positive lens (or the least amount of minus) which permitted clear single vision of a fixation target several meters distant. The near point of accommodation with no convergence was determined by the greatest amount of negative lens (or the least amount of positive) which permitted clear single vision of a distant fixation target. The limits of accommodation for various amounts of convergence were determined by placing an arbitrary amount of positive or negative lens in each lens holder and determining the farthest point and the nearest point at which the fixation object could be seen clearly and singly. The amount of convergence in degrees was computed from the position of the fixation target with respect to the centers of rotation, and the stimulus to accommodation was computed with respect to the anterior nodal point of the eye, taking into account the distance of the target, the power of the lens, and the position of the lens.

The results he obtained were then plotted on a rectilinear graph, the abscissa representing the convergence in degrees and the ordinate representing the accommodation in terms of the reciprocal of the distance for which the eye accommodated. For purposes of uniformity his graphs have been replotted in Fig. 1 with the convergence in centrads* and the accommodation in diopters. The nodal points and centers of rotation have been retained as reference points for specifying accommodation and convergence in replotting these graphs.

Donders made no provisions for determining the limits of accommodation for divergent positions of the fixation axes nor for determining limits of divergence beyond the position of parallelism. Consequently, the graphs in Fig. 1 offer no information relative to the limits to the left of the zero line of convergence.

One feature of Donders' procedure that seems to be out of order with respect to the determination of the limits of relative accommodation and convergence was his method of determining the maximum near point of convergence, which value is plotted in his graphs as the limit of convergence with the maximum of accommodation (Donders referred to this value as p). The method is best given by quoting, "Lastly, the absolute

*One degree is approximately equal to 1.75 centrads. One centrad equals a hundredth of a radian.

nearest point p is sought. This is not infrequently attended with difficulties. In those who voluntarily converge very strongly, it often succeeds best by looking with each eye separately, while the other eye is

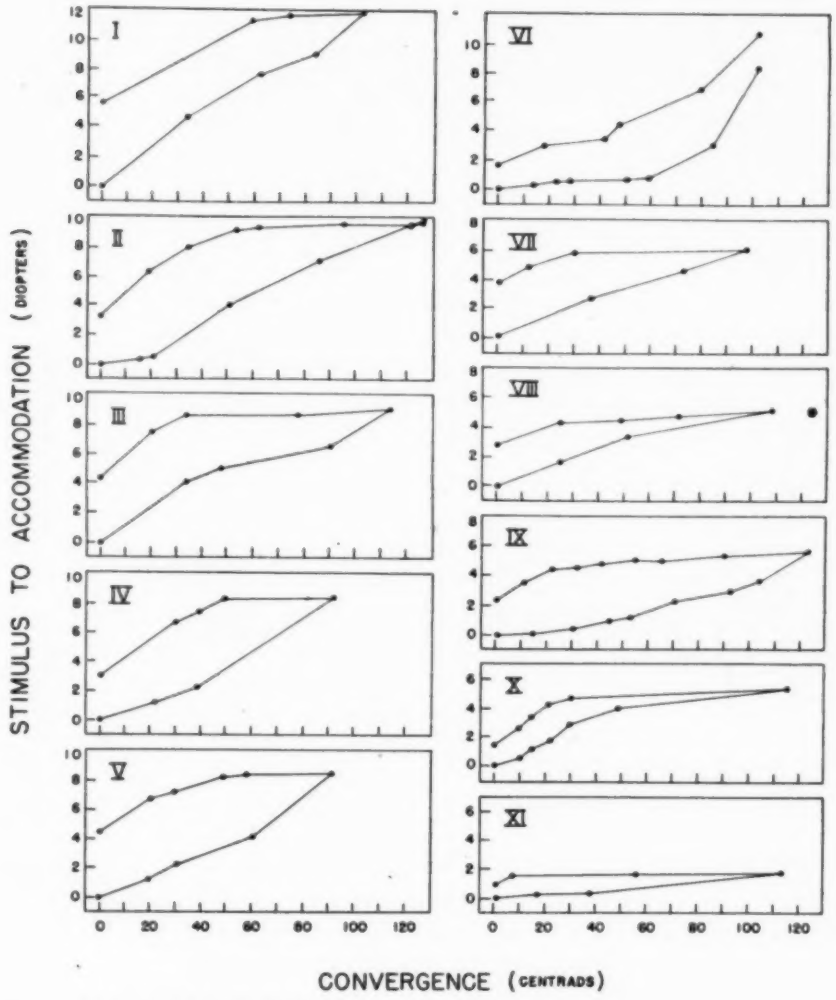

FIG. 1 GRAPHS FROM DONDERS

covered with a disc, at the maximum of convergence;". In his subsequent discussion of this point he indicates that the occlusion of one eye did not have to be resorted to in those cases which showed less ability to converge and in general in those who are strongly myopic. In any case, if one eye was occluded, he had no assurance that he was measuring the maximum near point of binocular convergence, rather, he would have

been measuring the maximum amount that the non-occluded eye could turn nasalward. This may account for some of the excessive values of maximum convergence that he obtained.

Figure 1 is a group of the graphs provided by Donders. The areas bounded by the plotted lines represent the zones of clear single binocular vision. The abscissa distance between the lines at any given level of accommodation represents the range of relative convergence at that level of accommodation; the ordinate distance between the lines at any given value of convergence represent the range of relative accommodation for that amount of convergence. Each graph is plotted so that the stimulus to accommodation represented by zero on the ordinate scale corresponds to the stimulus provided by a target at an infinite distance when the subject is wearing the correction indicated by a routine refractive examination. In the transcription of Donders' graphs it was assumed that the maximum positive lenses (or minimum negative) that permitted clear single vision of a target several meters away represents a routine subjective measurement of the spherical refractive error.

The following data are obtained from Donders' description of the subjects represented in Figure 1.

I. Subject: Dr. deHass; absolute hyperope of 12½ diopters with an amplitude of accommodation high for his age.

II. Subject: Girl, age 15; emmetrope.

III. Subject: Girl, age 17; relative hyperope of 5⅓ diopters.

IV. Subject: Man, age 21; emmetrope.

V. Same subject after practicing with negative lenses for several days.

VI. Subject: Myope of 7 diopters.

VII. Subject: Hyperope of 1⅓ diopters, age 16; cycloplegic examination indicated hyperopia of 4½ diopters.

VIII. Subject: Man, age 28; facultative hyperope of 1¼ diopters.

IX. Subject: Emmetrope, age 34.

X. Subject: Donders; presbyopic emmetrope, age 44.

XI. Subject: Emmetrope, age 60.

A study of the records obtained in this investigation indicated to Donders that the zones of clear single binocular vision were not of the same form in myopia, emmetropia, and hyperopia. His schematic graph for a typical myope shows only a very slight upward shift of the range of relative accommodatiton with the first increases in convergence and a rapidly increasing upward shift as the convergence approaches its maximum. Graph VI in Fig. 1 illustrates this type. His schematic graph for a

typical hyperope shows a very rapid upward shift of the range of relative accommodation with the first increases in convergence and a subsequent decrease in the rate at which the range shifts as the convergence approaches its maximum. Graph III in Fig. 1 illustrates this type. The scheme devised for the typical emmetrope approximates a combination of the myope and hyperope in that the curve for the lower limit has the form of the curve for the lower limit of the myope and the curve for the upper limit has the form of the curve for the upper limit of the hyperope. Graph IX in Figure I illustrates that of the typical emmetrope.

Donders presented two types of evidence to show that the three typical forms were acquired by practice. The first is the logical form of the graphs when considered in terms of the difficulties and needs of the myope or hyperope. In fixating objects binocularly at various distances it is necessary for the myope to start to converge before he starts to accommodate. Consequently, his ability to converge would be relatively greater for small amounts of accommodation. The hyperope, however, finds it necessary to accommodate before he starts converging. By the same logic, he would learn to increase his accommodation rapidly with small amounts of convergence. The second type of evidence is that offered by the results of practice as is illustrated in graphs IV and V of Figure 1. Thus Donders stated that practicing with negative lenses produces curves which approach those of a hyperope and that the use of positive glasses produces the accommodation-convergence relationship characteristic of a myope.

In 1880 Nagel[19] made a similar investigation that essentially substantiated the results of Donders. He attempted to simplify the graphical analysis of the accommodation-convergence relationship by the invention of the meter angle* as a unit of convergence. His report included several of Donders' graphs replotted with the abscissa in meter angles and the ordinate in diopters, as well as three cases of his own. Figure 2, graphs I, II and III represent Nagel's three cases replotted in centrads.

The following data were obtained from Nagel's description of the three cases represented by graphs I, II and III in Figure 2.

I. Subject: Man, age 23; myope of 4 diopters.

II. Subject: Dr. Schleich; myope of ½ diopter;

*Convergence in meter angles is equal to the reciprocal of the distance of the fixation object from each eye in meters when the fixation object is on a line perpendicular to the middle of the line connecting the centers of rotation of the two eyes. If the center of rotation is assumed to be practically at the nodal point of the eye, and if the specification of accommodation is expressed in diopters with reference to the nodal point, the meter angle and the diopter have a one to one ratio for any distance of fixation.

(This record is presented as evidence of the effectiveness of exercise by virtue of the fact that the subject had practiced the test some before these measurements were made. No preceding record was presented to show what changes had been made, however.)

III. Subject: Girl, age 13: hyperope of ⅓ diopter.

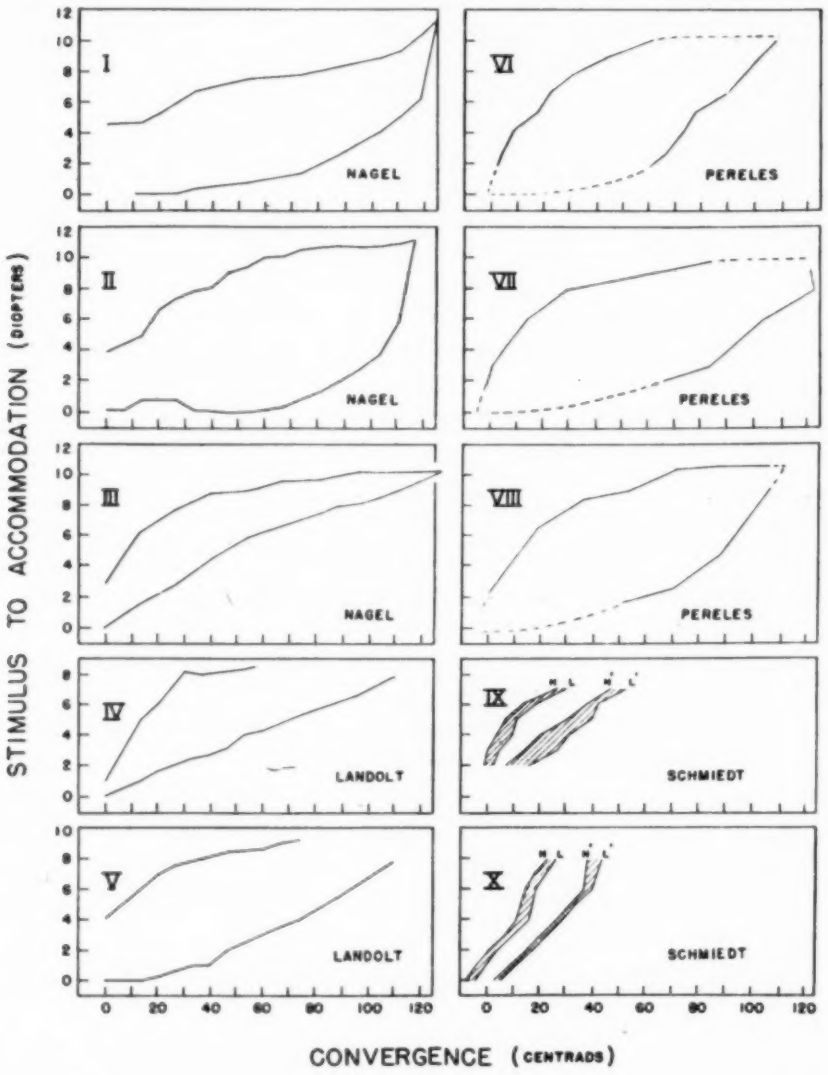

FIG. 2

Landolt[15] in 1886 contributed two graphs obtained by a method similar to that of Donders. These graphs are of the same subject before

and after training his eyes and are represented in graphs IV and V of Figure 2. The subject, a clinical assistant of Landolt's, was an emmetrope, age 26. No description of his training technique was given.

Pereles[22] in 1889 employed a mirror haploscope for investigating the accommodation-convergence relationship. The fixation target and the mirror for the left eye were mounted rigidly on an arm which pivoted about a vertical axis through the center of rotation of the left eye. The target and mirror for the right eye pivoted similarly about the center of rotation of the right. The arrangement of mirror and target was essentially the same as the arrangement of mirrors M and M′ and targets T and T′ in Fig. 6B so that the stimulus to convergence was provided by rotating the arms of the haploscope about the pivot points c and c′ which corresponded to the centers of rotation of the eyes. Since no lens system was provided the stimulus to accommodation was represented directly by the reciprocal of the sum of the distance from the target to the mirror and the distance from the mirror to the nodal point of the eye.

Pereles used a pair of bank notes, "Osterreichische Fünfguldennoten", as fixation objects since they were completely identical and could be readily fused. The notes also had a sufficient amount of fine detail to permit the detection of the least amount of blur.

Pereles determined the limits of negative relative accommodation or the relative far point of accommodation by placing the haploscope arms to correspond to various amounts of convergence stimulus and then increasing the distances of the two fixation targets simultaneously to the maximum amount that permitted a clear fused image of the bank notes. Decreasing the distance that permitted clear single vision gave the limit of positive relative accommodation or the relative near point of accommodation.

The limits of positive relative convergence were obtained by placing the fixation targets at various distances and determining the maximum amount of convergence that permitted a clear fused image of the bank notes.

The minimum amount of convergence (or maximum amount of divergence) that permitted a clear fused image gave the limit of negative relative convergence.

Graphs VI and VII of Fig. 2 are plotted from Pereles' data from two series of determinations of the limits of relative convergence on himself. Graph VIII in the same figure is obtained from a series of determinations of the limits of relative accommodation. The limitations of his

haploscope were such that he could not provide a stimulus to accommodation of less than 1.9 diopters without the use of concave mirrors instead of the plane mirrors. Although he provided data to show the nature of the curves below the 1.9 diopter level of accommodation, these data were obtained in separate series so that he found it more expedient to approximate the trend of the limits below the 1.9 diopter level with broken or dashed lines. The plotting of the actual data would have produced a discontinuity which would have been an artifact dependent in part at least upon the optical distortions provided by the spherical mirrors.

Pereles took several series of measurements on himself, an emmetrope, age 22, and on his colleague, Franz Halsch, an emmetrope, age 25, both of the limits of relative convergence and of relative accommodation and obtained practically the same results by the two methods. In other words, the limit of negative relative accommodation and the limit of positive relative convergence were the same, as were the limits of negative relative convergence and positive relative accommodation.

Although a comparison of the graphs VI, VII, and VIII shows considerable variation in the area of the zone of clear vision from one set of findings to the next, Pereles believed that the curves representing the limits of the zone could be expressed by a simple mathematical equation. The interpretation of the equation he devised to fit the data is that both the logarithm of the latent accommodation and the logarithm of the latent relaxation of accommodation are linear functions of convergence. By latent accommodation he meant the dioptric difference between the absolute near point of accommodation and the relative near point of accommodation for a given amount of convergence and by latent relaxation of accommodation he meant the dioptric difference between the absolute far point of accommodation and the relative far point of accommodation for a given amount of convergence.

Pereles then determined the zones of clear vision for two myopes, both of whom had been wearing their proper corrections. By substituting the values in his empirical equation he could obtain a curve that fitted the data almost perfectly. He then concluded that the equation held for myopes and emmetropes and that, therefore, it was not possible to ascribe a different shape of graph to the myopes as Donders had done. Pereles did not have the opportunity to use any hyperopes in his investigation, but he ventured the guess that the form of the hyperopes' curves would be no different.

In 1893, only a few years after Pereles' study, Schmiedt[25] used the same haploscopic arrangement and procedure to investigate the influence of raising and lowering the directions of fixation on the zone of clear single binocular vision. He made the measurements with the haploscope horizontal, the haploscope tilted up 25°, and then down 25°. For all of these positions the tilt of the head remained constant. He found that the position of the fusion range is sometimes the same in the upward position as in the horizontal position or in the downward position, but that usually the range is shifted toward less convergence in the upward position and toward more convergence in the downward position. Two of his graphs have been replotted in Fig. 2, graphs IX and X. The H and H′ indicate the limits of relative convergence obtained in the upward position, L and L′ indicate the limits obtained in the downward position. The results from the horizontal position are not included in this report, but it suffices to say that the limits lay intermediate between the HH′ and LL′ limits. Graph IX of the figure represents a 30 year old emmetrope. Graph X is that of a 17 year old emmetrope. It is to be observed that, in spite of the fact that both of the subjects are emmetropes, one produces a graph resembling Donders' typical myope's graph, and the other produces a graph resembling Donders' typical hyperope graph. It is also worthwhile noting that although the upward and downward tests may show a shift of the graph, there is no change in the slope of the graph. Among his conclusions Schmiedt states that his data not only do not substantiate Pereles' formula but that the forms of his curves often were very different from those of Pereles.

An attempt to make a direct clinical application of the information gained by plotting the zone of clear single vision was most extensively carried out by Percival in 1892.[20, 21] His data were obtained by means of trial lenses and rotary prisms with the fixation object at various distances. The stimulus to accommodation was determined by the combination of lenses in front of the eyes and the reciprocal of the distance of the fixation object. The maximum convergence was determined from the near point of convergence by a push-up technique. He then translated all his findings into meter angles of convergence and diopters of accommodation and plotted the zone of clear single binocular vision. Graphs I, II, III, IV, and V of Fig. 3 are replotted from his graphs.

The following notes are taken from Percival's descriptions relative to the graphs:

I. Subject: Dr. Mable Campbell; graph represents the normal chart for a .50 diopter hyperope.

II. Subject's age, 24; simple hypermetropia of +6.00 diopters but the manifest binocular hypermetropia was only +3.00 diopters. When lenses stronger than +3.00 diopters were given his eyes diverged; Percival prescribed +5.00; the subject complained of discomfort for the first few days but later professed himself to be much pleased with the glasses; the short line near the bottom of the chart represents findings made after wearing the glasses two weeks.

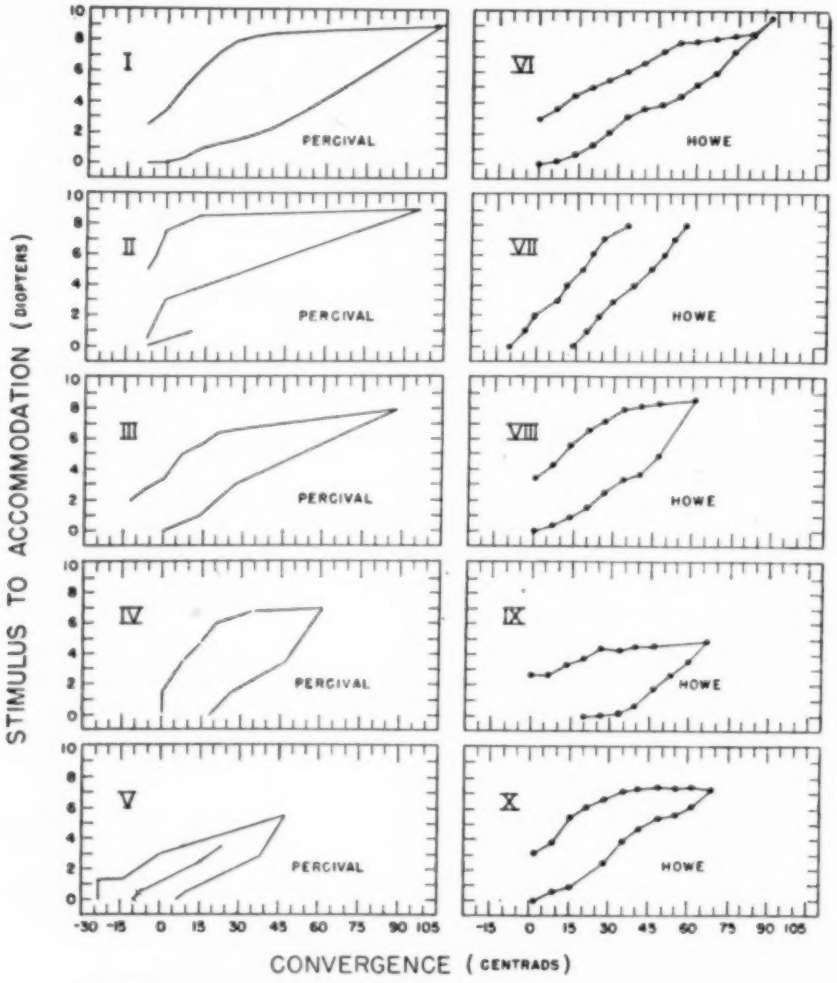

FIG. 3 GRAPHS FROM PERCIVAL AND HOWE

III. Subject's age, 25; classified as a neurotic emmetrope; subject to headaches, pain in the eyes, and attacks of conjunctivitis; subject had been given +1.00 for reading but this prescription was found to increase the difficulty. Percival prescribed 1° prism base in for constant use; this relieved the pain and symptoms.

IV. Subject's age, 29; refractive error +.50 diopter. +1.00 for reading gave some relief; the final prescription, +.50 O. U. with 1° prism base out gave satisfactory results.

V. Subject; woman, age 39; reported headaches all her life, believed to be true migraine with attacks of giddiness; refractive error

O. D. +.25 +.50 x 130°
O. S. +.50 +.50 x 10°

Percival prescribed for distance O. D. +.25 +.50 x 130
O. S. +.50 +.50 x 10

combined with 1½° prism base in, and prescribed for near

O. D. +1.25 +.50 x 130

O. S. +1.50 +.50 x 10; results—no fatigue from near work and almost free of headaches.

The middle line connecting the x's in graph V represents the phoria obtained with various amounts of stimulus to accommodation. Percival measured the phorias by means of a Maddox glass rod and the cover test.

From his clinical experiences with people who showed anomalous ranges of clear vision Percival established a zone which he referred to as the zone of comfort. This zone includes the middle third of the range of relative convergence for all values of accommodation up to 3.00 diopters. His principle was that, if the point of demand, i.e. the point on the graph which showed the necessary amount of convergence for any given distance of fixation beyond 33 cm. was within the zone of comfort, satisfactory binocular vision could be expected. It would, of course, be possible to place the point of demand within the zone of comfort, satisfactory binocular vision could be expected. It would, of could not make the adaptation as did the subject in graph II.

Percival denied the validity of the phoria as a criterion because he did not always find the phoria line within the zone of comfort.

In 1900, Howe[13 14] described an instrument for measuring relative accommodation and convergence which was essentially a refinement of Donders' optometer. For a fixation object he used a reduced photograph of a chart of letters designed for measuring acuity. In the lens holders he employed prism lenses in addition to the positive and negative spheres used by Donders. The use of prisms enabled Howe to make measurements with divergent positions of the eyes. The convergence was determined by the position of the target and the amount of prism in the lens holders. The measurement so obtained was changed to meter angles

for plotting. The accommodation was determined by the target distance and the amount of sphere in the lens holders, and was expressed in diopters with respect to the nodal point.

Howe's graphs are replotted in centrads and diopters in Fig. 3, graphs VI-X. The following notes are obtained from Howe's discussion of the graphs:

Graph VI. Subject: Emmetrope; graph represents a normal set of data obtained by measuring the maximum amounts of positive and negative spheres which permits clear single vision for various distances of the fixation target. Thus the graph represents the limits of relative accommodation.

Graph VII. Subject: Emmetrope; graph represents a normal set of data obtained by measuring the maximum amount of gradually increased prism power base in and base out that permit clear single vision of a fixation object at various distances. Howe points out that this method of measuring the zone of clear vision, i.e. determination of the ranges of relative convergence, is often likely to produce limits more nearly parallel than the lines representing the limits of relative accommodation. (cf. graph VI:)

Graph VIII. Limits of relative accommodation of a subject showing about .50 diopter of myopia and classified by Howe as an example of "actual excessive accommodation." The symptoms of this type are characterized by a tendency to over-accommodate in any given situation—miotics act quickly, cycloplegics slowly, pupils small, characteristic wrinkles appear on forehead, and the positive relative accommodation is high while the negative relative accommodation is low. Howe recommends a rest for this type of case.

Graph IX. Limits of relative accommodation of a subject showing —3.00 diopters of myopia and classified by Howe as an example of "relative excessive accommodation." The symptoms of this type appear to be directly related to the consequences of a true myopia dependent upon the distension or distortion of the eyeball. The inconveniences experienced are remarkably slight in view of the imbalances evident from the graph, that is, if the myopia correction were removed. Howe's treatment of this form of simple imbalance is that of restoring the proper balance by a proper correction of the refractive error.

Graph X. Limits of relative accommodatiton of a subject showing +2.00 diopters of hyperopia and classified by Howe as an example of "relative insufficient accommodation." The symptoms of this type are characterized by a tendency to underaccommodate in any given situation, or at least in finding difficulty in accommodating the proper amount for any given distance, i. e. without glasses. The subjective symptoms are very complex. The treatment consists in a very accurate correction of all refractive errors, the use of exercises to adapt the patient to his needs, a

possible change in vocation to alleviate his visual tasks, and a careful watch over his general health.

In 1901, Hess[9] described a method for measuring the range of single binocular vision that would eliminate the effects of decreases in pupil size at higher levels of accommodation and for eliminating the effect of the increase in the visual angle subtended by a fixation object as it was made to approach the eye. These two factors, he explained, both helped to produce the "curves" of the previous investigators instead of straight and parallel lines.

Hess modified Pereles' haploscopic arrangement by using totally reflecting prisms in place of mirrors. The apparatus also included lens holders, so that a wider range of accommodation could be obtained. His fixation or fusion objects consisted of small circular spots of light on black backgrounds. He varied the size of the circular spots to conform to the distance at which they were placed so that the visual angle subtended by the spot would remain practically constant during the experiment. In front of one eye he placed a small disc perforated with two small holes, the separation of which was less than the smallest working diameter of the pupil. This disc enabled him to determine whether or not the fixation object was in focus, since the spot of light would be seen double whenever it was out of focus. The disc was so placed in front of the eye that the perforations were vertically aligned and thus permitted a measure of the accommodation in play in the vertical meridian of one eye independently of pupil size. In front of the other eye was placed a red glass so that the fused image of the red spot of light seen with one eye and the single, "in focus" white spot seen with the other eye indicated that the stimulus to accommodation and the stimulus to convergence were both within the limits of the zone of clear single binocular vision. Slowly changing the stimulus to convergence until either the red and white spots failed to fuse or until the single white spot started to become double gave one limit of the range of relative convergence. Changing the convergence stimulus in the opposite direction gave the other limit. The limits of relative accommodation were obtained by simultaneously increasing or decreasing the dioptric distance of the fixation objects until fusion became impossible or the white spot doubled.

Hess obtained straight lines for the limits of the zones of clear single vision by both procedures and these lines in his case were practically parallel to the line of demand. Graph I in Fig. 4 represents Hess' record of the limits of relative convergence and accommodation. The

horizontal lines at the bottom and top represent limits of relative accommodation while the oblique lines represent limits of relative convergence.

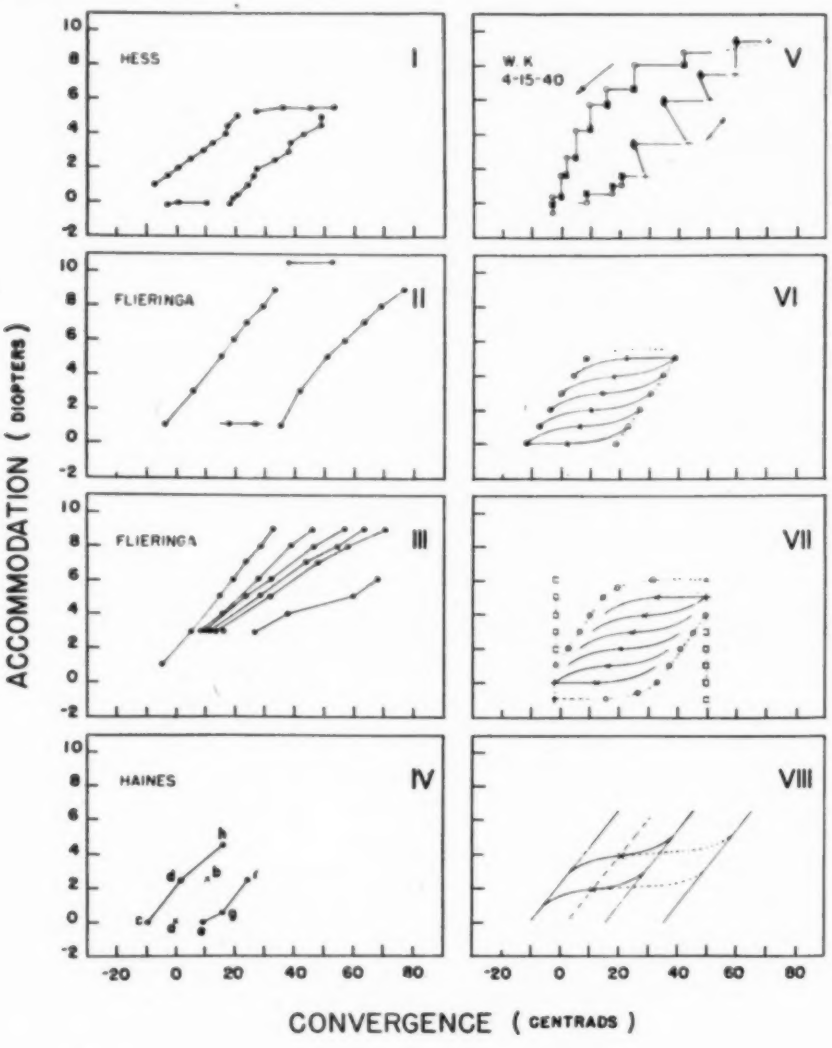

FIG. 4.

Hess postulated a linear relationship between convergence in degrees and accommodation in diopters within the limits for which changes in ciliary muscle contraction induced changes in the curvature of the crystalline lens. The upper limit of the graph, according to this concept, represents the limit of changes of curvature in the crystalline lens but

does not necessarily represent the limit of contraction of the ciliary muscle. Consequently, if the subject is capable of forcing a contraction of the ciliary muscle beyond this degree a maximum of convergence could be obtained considerably in excess of the point at which the line representing the near point of accommodation intersects the limit of positive relative convergence. Hess believed that this is what happened for example, in Donders' graphs which showed an increased ability to converge at the maximum level of accommodation (cf. Fig. 1, Graph X).

Thus Hess further postulated a range of latent accommodation above the near limit of manifest accommodation. The physiological correlate of the range of latent accommodation was of course the ability of the ciliary muscle to contract in excess of the contraction necessary to obtain the maximum increase in curvature of the crystalline.

Hess found some difficulty in obtaining evidence of an analagous situation to the lower level of accommodation, i.e., the possibility of a distension of the ciliary muscles beyond the degree at which the crystalline lens reaches its least curvature. The fact that the lower limit of accommodation on the graph was represented by a straight line, however, indicated to him that the analagous situation was true.

In 1924 Flieringa and van der Hoeve[5, 11] obtained further evidence in favor of Hess' concept in an investigation employing the same measuring technique. The results obtained under normal conditions were essentially the same as those obtained by Hess. The chart of the results obtained with Flieringa as subject are shown in Graph II, Fig. 4. Flieringa, age 31, was a myope of approximately one diopter.

Flieringa and van der Hoeve then reasoned that if there is a linear relationship between convergence and ciliary muscle contraction there should be a change in the ratio between the two responses if the ciliary muscle were partly paralyzed. This change should manifest itself by a change in the slope of the lines representing the limits of relative convergence so that the ratio of convergence to manifest accommodation would be increased. They further reasoned that, if there was a range of latent accommodation as Hess believed, they should be able to observe these changes with small amounts of paralysis without finding any evidence of decrease in the amplitude of accommodation. In other words, if the range of muscle contraction normally exceeded the amount necessary for the maximum manifest amplitude, the same maximum manifest amplitude would be reached under partial paralysis by an added innervation to accommodation which at the same time would increase the number of degrees of convergence per diopter of manifest accommoda-

tion. They proposed the term "myodiopter" to represent the innervation to contraction of the ciliary muscle that produced a change of accommodation of one diopter under normal conditions and within the limits of the manifest range of accommodation. Thus, if the ciliary muscles were half-paralyzed two myodiopters would be required to produce one diopter, and if the muscle were two-thirds paralyzed three myodiopters would be required to produce one diopter. Finally, they reasoned, if the ratio of convergence to accommodation were measured at the moment when the paralysis was on the verge of effecting a change in the amplitude of accommodation, the range of latent accommodation could be computed in myodiopters. Thus if the ratio of convergence to accommodation is tripled in this measurement and if the amplitude of manifest accommodation is normally 8 diopters, the total range of muscle contraction is 3 x 8 or 24 myodiopters. Accordingly the maximum near point of convergence should be represented in such a case by an extension of the line representing the limit of positive relative convergence upward on the graph to its intersection with the ordinate value corresponding to 24 myodiopters. If the results of the investigation bear out these relationships, they would substantiate Hess' explanation of Donders' graphs showing the excessive amounts of convergence possible at the maximum level of accommodation.

The measurements in this phase of the investigation were, for various reasons, confined to the determination of the limits of negative relative convergence. The paralysis was artificially induced by the instillation of homatropine. The measurements were made after the subjects had reached the maximum degree of paralysis and were recovering from the influence of the drug, since the recovery process was slower and gave more ample time to make the measurements.

The limits of negative relative convergence obtained at various times during the recovery are shown in Graph III, Fig. 4. The longest line is that obtained under normal conditions. The findings obtained at the moment the normal amplitude of accommodation reached its normal value is represented by the line farthest to the right. The limits obtained by successive series of findings during the period of recovery after the normal amplitude was reached are represented by the lines from right to left successively. On the basis of the difference in slope of the two extreme lines Flieringa and van der Hoeve estimated that the subject, Flieringa, had an amplitude of about 25 myodiopters.

They then compared the maximum convergence that could be obtained with that which would be predicted by the method described

above. This comparison was made for two subjects and was found to substantiate the theory. There is, however, one questionable point. The maximum convergence in both cases was stated to be about 85° without any clear description of how this measure was obtained. It is possible that this does not represent the convergence obtained by a push-up technique but rather that it represents the sum of the amounts that each eye can turn nasally. One reason for suspecting this meaning is that a half of 85° corresponds very closely to normal values obtained in the measurement of nasal limits of monocular fixation. One reason for suspecting that the binocular maximum of convergence is not meant is supplied by the measurements of the near point of convergence by Duane[4]. In a group of 409 cases between the ages of 16 and 40 the highest convergence recorded is 76° with only 4% falling between 64° and 76°. Of more than 800 cases, including all ages, only 4% were between 64° and 76° with the age interval 46-50 showing the greatest per cent. Thus, it seems almost impossible to believe that the only two cases reported in Flieringa and van der Hoeves' article both had maximum convergences of about 85° by the binocular near point technique.

Very recently a determination of the average zone of clear single vision in 100 random cases was made by Haines[8]. The group included only subjects who were found to have at least a 5 diopter amplitude of accommodation and who showed no evidence of pathological conditions or other anomalies that might produce spurious findings. Each of the 100 subjects was examined for cylindrical and spherical refractive errors and corrected with the most plus (or least minus) that permitted the maximum obtainable visual acuity at 6 meters.

Graph IV, Fig. 4, represents a chart plotted from the average values of the following findings taken through the above correction.

a. Phoria at 6 meters.
b. Phoria at 40 centimeters.
c. Prism base-in-to-blur with the fixation chart at 6 M.
d. Prism base-in-to-blur with the fixation chart at 40 cm.
e. Prism base-out-to-blur with the fixation chart at 6 M.
f. Prism base-out-to-blur with the fixation chart at 40 cm.
g. Plus sphere to blur with the fixation chart at 40 cm.
h. Minus sphere to blur with the fixation chart at 40 cm.

The prism findings were mathematically corrected to represent the true stimulus to convergence at the center of rotation.

The graph demonstrates the degree of parallelism that can be ex-

pected between the limits of positive relative convergence, the limits of negative relative convergence, and the phoria line in a routine eye examination.

A rather unique investigation of the relationship between accommodation and convergence was made by Roelofs[24] in 1913. Roelofs measured (1) the phorias and (2) the maximal amounts of stimulus to divergence that permitted clear single vision under various amounts of stimulus to accommodation. The stimulus to accommodation was controlled by minus spheres while the subject fixated the small letters of a distant acuity chart. The phorias were measured with rotary prisms and a Maddox glass rod in front of one eye. A small spot of light directly below the acuity chart provided a source of light for the Maddox rod streak. The maximal divergence was measured by increasing the power of the prism base-in to the maximum amount that permitted clear single vision.

The maximal divergence values are shown in Graph I, Fig. 5. *A* and *B* represent the results obtained by two variations in procedure. The following procedure was employed for obtaining *B*. With no stimulus to accommodation the subject slowly increased the prism power until it had gone just beyond the value which permitted steady and clear single vision, or "ruhiges Sehen." Without changing this prism stimulus he maintained a continuous attempt to regain a steady clear single image of the fixation letters. If this were accomplished within 5 minutes the prism power was increased by one degree and the attempt to regain a steady clear image was continued. When the prism power had in this manner been increased to the point at which he was unable to obtain "ruhiges sehen" within a 5 minute period the value was recorded as the maximal divergence for these conditions. The stimulus to accommodation was then increased one diopter at a time and the procedure was repeated for each step. When the maximum of accommodation was reached the stimulus to accommodation was reduced in one diopter steps. The measurements obtained in increasing steps of accommodation are seen in the graph to be slightly to the right of those obtained in decreasing steps.

The procedure employed for obtaining *A* was exactly the same except that a 15 minute time interval for regaining steady clear vision was allowed instead of a 5 minute interval.

Roelofs concludes from this that with exercise and patience one can attain the same degrees of divergence at all levels of accommodation

and, vice versa, one can attain the same degrees of accommodation at all degrees of divergence. He then points out that the difference in Donders'

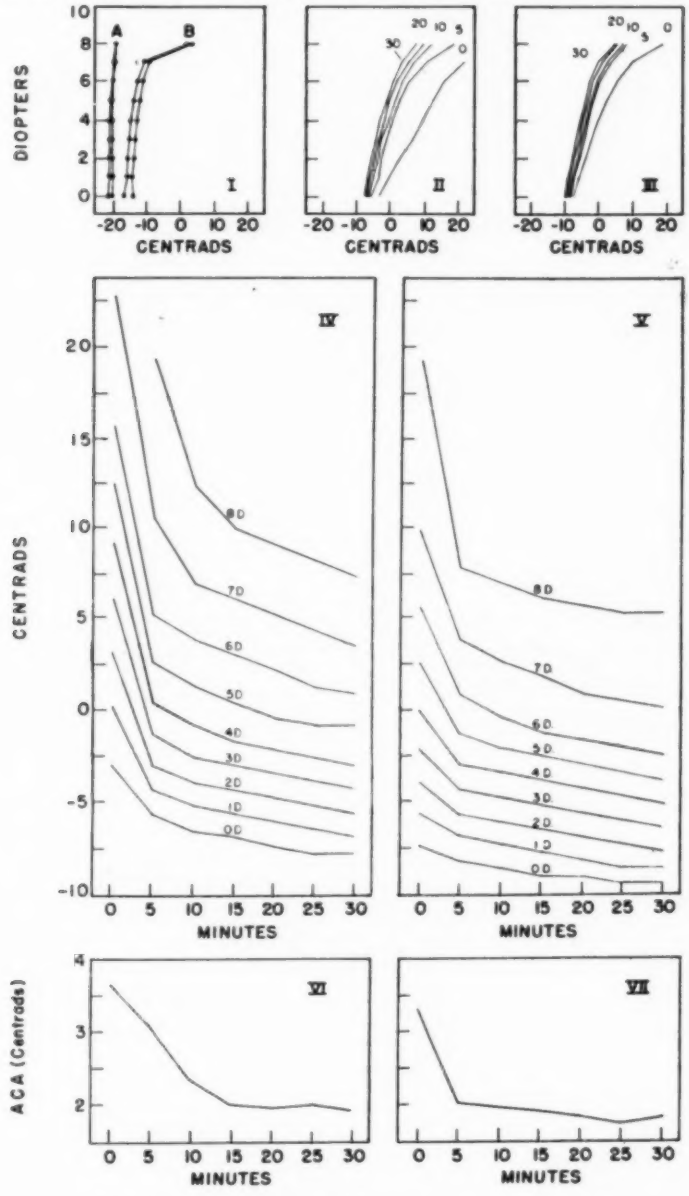

FIG. 5 GRAPHS FROM ROELOFS

curves for the myope and the hyperope is dependent upon the exercising of a specific region so that the myope increases the range of positive

relative convergence and the hyperope increases the range of negative relative convergence.

Roelofs' measurements of the phorias are charted in graphs II and III of Fig. 5. The data for graph II were obtained as follows: The subject fixated and kept clear a distant acuity chart for half an hour with the Maddox rod and rotary prisms before one eye. Every five minutes during the half hour period a phoria test was made and plotted in the graph at the zero level of accommodation. The same procedure was followed for successive increases in stimulus to accommodation in one diopter steps and the results of the phoria tests were plotted on the graph at the corresponding level of accommodation stimulus. Not all of the results are charted in the graph, but a sufficient number of points to show the trend are included. The curve connecting the phoria values at the beginning of each test is indicated by zero. The curves connecting the phoria values at the end of 5, 10, 20, and 30 minutes are indicated by the time intervals.

The procedure in graph III is the same as that in graph II except that the half hour test at each level of accommodation is preceded by a half hour rest period with the eyes closed.

From these graphs Roelofs concluded that in the absence of single binocular vision there is not only an increase in exophoria but that also the ratio of convergence to accommodation as indicated by the phorias is greatly reduced. These results indicated to him that a further prolonged absence of binocular vision would finally eliminate any interdependence between accommodation and convergence.

However, if the analysis of his data from the phoria measurements is carried a little further it can be shown that Roelofs' prediction of an eventual elimination of a ratio between convergence and accommodation is not indicated. This can be shown graphically in two ways. The first is to plot the trend of the phoria at each level of accommodation during the half-hour test period. In graph IV this is done for the data from which graph II was obtained; in graph V the same is done for the data of graph III. The level of accommodation represented by each curve is indicated by a number representing the dioptric stimulus. If the ratio between convergence and accommodation as represented by the phorias is approaching zero, the trend of all the phorias should be toward a common point, or, graphically speaking, all of the curves in graphs IV and V should appear to be converging toward a common point far to the right of the graphs, and if the ratio is approaching some constant

value greater than zero the lines should appear to trend toward a series of parallel lines. Roelofs' prediction would amount to deciding in favor of the former. The graphs certainly indicate the lack of evidence in favor of either.

A second graphical method for showing the lack of evidence is illustrated in graphs VI and VII. The term ACA used in the ordinates is a convenient way to express the ratio of accommodative convergence to accommodation when accommodative convergence represents the increases in esophoria (or decreases in exophoria) with increases in accommodation. An ACA value of 5 centrads, for example, means that one diopter of accommodation produces a change of 5 centrads in convergence as measured in the phoria test. In graphs II and III the ACA values would be represented in the slopes of the curves which, of course, would not be constant since they are curves and not straight lines. A representative ACA can be obtained for each interval of time, however, by averaging the differences in phorias for each change of one diopter of accommodative stimulus. These representative ACA values are plotted against time in graphs VI and VII. Graph VI is plotted from the data of graph II while graph VII is plotted from the data of graph III. In both graphs it is evident that practically all of the decrease in ACA takes place during the first few minutes. If the ACA is eventually to each zero, the curve will continue to approach the zero ordinate, but if the ACA is eventually to assume some positive value greater than zero the graph should appear to level off at some ordinate above zero. The graphs offer no conclusive evidence in favor of either, but one could be inclined to suspect that the ACA had reached a constant value after the first few minutes. This, however, is opposite to the prediction made by Roelofs that the ratio would be eliminated in time.

In connection with Roelofs' concept of the temporary nature of the interdependence between accommodation and convergence it is worthwhile mentioning at this point a recent report[12] on some objective measurements of the ACA ratios present in a group of 15 squinters. The duration of the tropias in this group varied from 1 to 34 years. Every squinter showed some positive value for the ACA and the average for the group was 4.2 centrads per diopter.

APPARATUS AND PROCEDURE

In Fig. 6 are shown the two arrangements of the apparatus employed in this study. The arrangement *A* is used to measure the accommodation in play while the stimulus to accommodation and the stimulus to con-

vergence are being varied independently. The arrangement *B* is used to determine the limits of clear single binocular vision when blurring or diplopia are depended upon as criteria for the determination of the limits. The apparatus represents essentially a modified type of Hering's mirror haploscope.

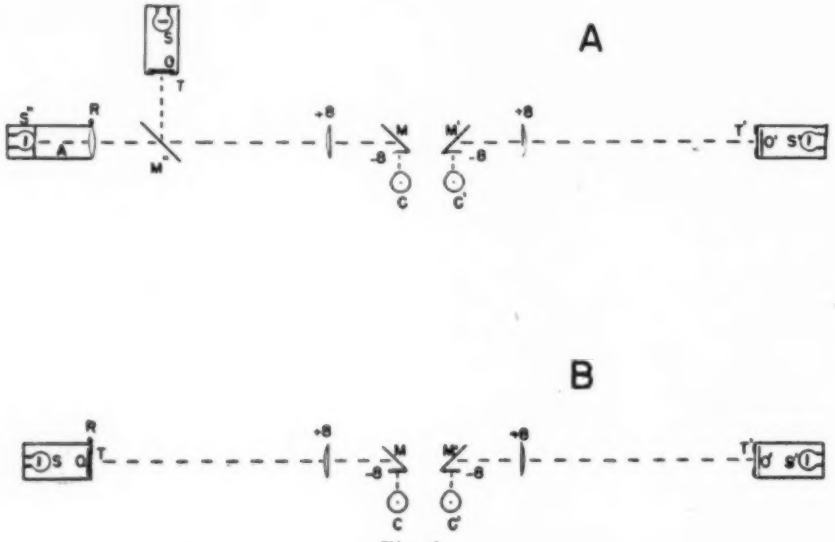

Fig. 6.

In both diagrams, *c* and *c'* correspond to the centers of rotation of the eyes of the observer or the subject. The separation of the pivoting centers of the two arms of the haploscope can be adjusted to correspond to the separation of *c* and *c'* of the subject, which, for practical measuring purposes was considered to be equal to the subject's interpupillary distance. With the proper adjustment of the distance of the subject's eyes from the instrument the arms of the haploscope can then be said to pivot or rotate about vertical axes through *c* and *c'*.

On each arm of the haploscope in Fig. 6B is mounted a front-surface mirror M (or M'), a minus 8 diopter lens between the mirror and the eye, a target T (or T') and a +8.00 diopter lens between the mirror and target. The positions of the +8.00 lens, the mirror, and the —8.00 lens are so fixed that the secondary focal point of the combination lies 10 mm. in front of the pivoting centers to correspond to the plane of the entrance pupil of the subject's eye. This arrangement represents essentially a Badal optometer system for each eye since the visual angle subtended by the image of the target T (or T') remains constant

irrespective of the distance of the target T (or T′) from the combination of lenses and mirrors. The stimulus to accommodation is determined by the reciprocal of the distance of the image of the target T (or T′) formed by the lens system from the plane of the spectacles, 27 mm. in front of *c* and *c′*. This reciprocal value is represented by diopters when the distance is measured in meters.

The targets T and T′ are photographs of a standard Snellen acuity chart reduced 38 times so that the letters as seen in the haploscope subtend the same visual angles at the entrance pupil as the letters seen on the Snellen chart at its standard distance of 6 meters. The photographs are positive prints on a transparent film. Directly behind each target T (or T′) is a plate of milk glass O (or O′) which diffuses the light from a 7½ w. bulb S (or S′) so that the targets are seen as black letters on a white ground. The white ground is circular in shape and subtends a visual angle of 12 degrees. Peripheral to the white ground there is nothing to be seen by the subject except the dull brass in which the optical system is mounted and which itself blocks out all of the peripheral field of view within 30° of the line of sight.

The stimulus to convergence is controlled by the rotation of the arms of the haploscope about the points *c* and *c′*. The diagram shows the haploscope set at zero stimulus to convergence.

A constant speed electric motor is connected to the haploscope by means of a pair of reversible gear shifts so that the stimulus to accommodation can be increased or decreased at the rate of 1.50 diopters per minute and the stimulus to convergence can be increased or decreased at the rate of 30 centrads per minute. The stimulus to accommodation and the stimulus to convergence are independently controlled, making it possible to increase, decrease, or make no changes in the one stimulus while the other is increased, decreased, or held constant. The stimuli to accommodation are equal for the two eyes at all times and increase or decrease simultaneously at the same rate.

The stimulus to accommodation and the stimulus to convergence at any given moment are indicated by a recording pencil at R which traces the path of the target T on specially designed graph paper located directly beneath the left arm of the haploscope. The tracing on this graph can then be transcribed to a rectilinear graph with centrads along the abscissa and diopters along the ordinate.

A transcription of a record that was obtained by means of the arrangement in Fig. 6B is shown in Fig. 4. -V. The procedure by which

the record was obtained is as follows: The apparatus is properly adjusted to the subject's inter-pupillary distance; the head rest and chin rest are adjusted until the subject is looking through the centers of the apertures containing the —8.00 lenses and until the distance from the cornea to the edge of the aperture is estimated to be 22 mm., this being the distance which places the center of rotation of the normal eye at the pivoting centers of the haploscope arms.

The stimulus to accommodation is set at zero and the stimulus to convergence is set at about —10 centrads, i.e., 10 centrads of divergence, or more, to prevent fusing of the targets. At this setting the subject can compare the two targets for height (hyperphoria) and inclination (cyclophoria). Corrections for hyperphoria are made by tilting one of the mirrors about a horizontal axis through the optical center of the +8.00 lens. Corrections for cyclophoria are made by rotating the target holder about this same axis. When all of the adjustments are made, the stimulus to convergence is increased until the targets fuse. At this point the subject is asked to name the smallest letters that he can read. If these correspond reasonably with his known acuity from a preceding routine examination the zero level of accommodation is used as a starting point. This starting point is represented by the end of the horizontal line segment at the lower extreme of the graph. If the letters named by the subject do not correspond to his known acuity or if the subject reports that the letters seem blurred, the stimulus to accommodation is slightly increased to see if an improvement is possible. If so, the test is started at some higher level of accommodation at which his maximum acuity can be obtained. This situation may occur in myopes who are not wearing a full correction or in individuals who tend to over-accommodate as a result of the awareness of nearness of the target.

In general, the starting point is arbitrarily quite near the zero levels of accommodation and convergence, but the fact that it may be found at some distance from the zero points in many of the graphs has no special significance, for it merely represents an attempt to get well within the zone of clear single vision.

The operator then has one of several choices in starting to measure the limits. He can start to increase or decrease either the stimulus to convergence or the stimulus to accommodation or start a combination of two. In any case, a limit is going to be reached at which the subject will report either a blur or a diplopia. He is instructed not to report either a blur or a diplopia until he is certain of his observation. He is also instructed to do his best to prevent the occurrence of either. In Fig. 4 (V)

the horizontal line leading from the starting point indicates that the test was started by increasing the stimulus to convergence. The circle at the end of the first segment indicates that the subject reported a blur. The

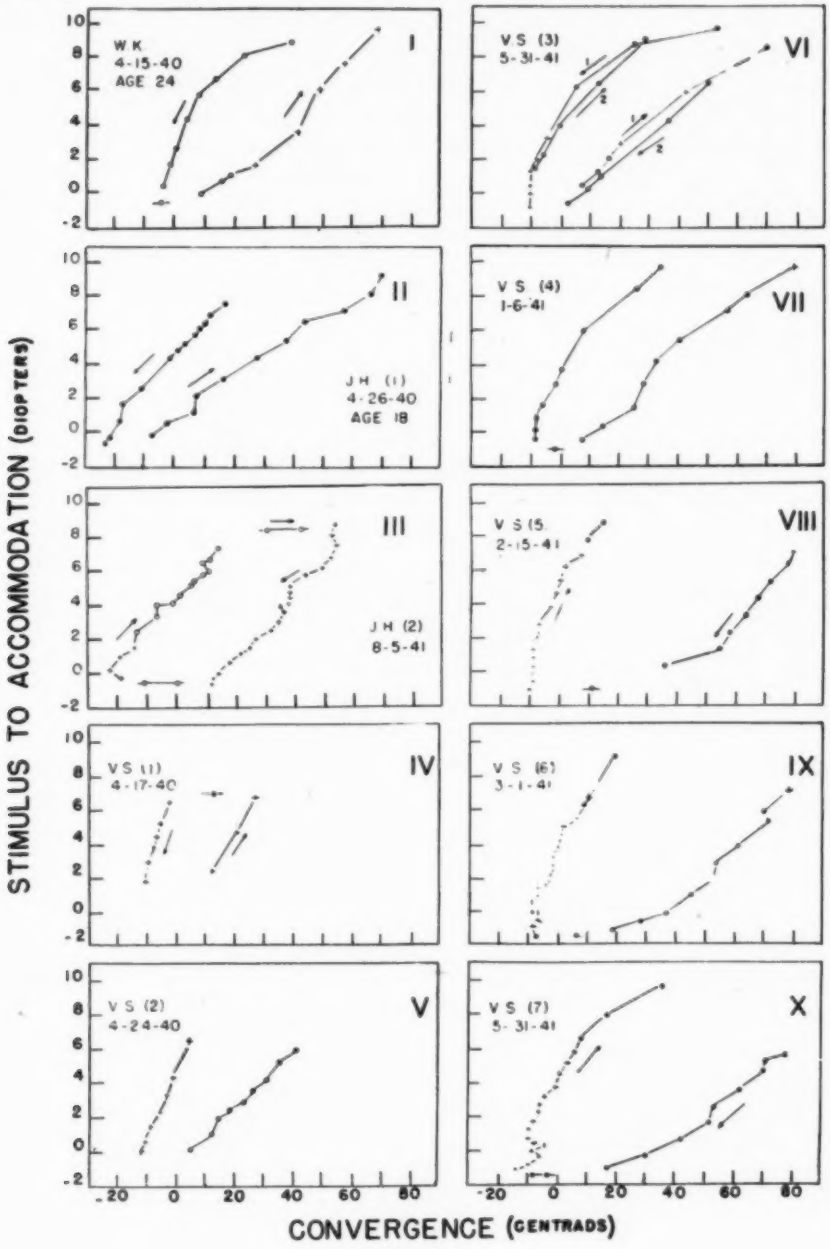

Fig. 7.

operator then stops the convergence stimulus from increasing and starts to increase the accommodation stimulus until the letters are reported clear again. The "clear" is represented by a solid rectangular symbol. Then the convergence is increased to blur, the accommodation to clear, etc. At about the 1.50 diopter level it is found that the letters do not blur with an increase in convergence stimulus, but double instead. This is indicated by a plus sign (+) on the graph. At this point in the example being described the procedure is quite arbitrarily changed by increasing the accommodation stimulus and decreasing the convergence stimulus at the same time. This results in the tracing of an oblique line instead of a vertical or horizontal line on the graph. The subject's report of a fusion of the targets with clear vision is represented by a solid diamond shaped symbol.

With this explanation the graph can be followed to the maximum limit of convergence or the limit of the apparatus. In the case shown the limit of stimulus to accommodation that can be obtained in the instrument is less than the subject's amplitude of accommodation. If the subject's amplitude were within the range of the instrument it would be possible to determine any number of blur points indicating the maximum level of accommodation for various degrees of convergence. Since the maximum amplitude can not be reached in the example described, the operator varies the stimuli to accommodation and convergence until fusion and clear single vision are again obtained. The operator then explores the zone of clear single vision at the opposite limit in much the same way except that the stimulus to convergence is this time reduced until a blur (or a diplopia) is obtained and then the stimulus to accommodation is decreased to the point of recovery. The lowest limits of accommodation are attained by decreasing the accommodation stimulus in the neighborhood of zero convergence until a blur is reported. This is represented in the example as the lowest circle on the graph.

Another variation in procedure is the entire reversing of the order of obtaining blur and diplopia points by increasing the stimulus to accommodation at the beginning of the test and determining the left side of the graph first. The arrows indicate the order in which the tests were made. In some cases part or all of the graph may have been repeated in the same or in the opposite direction. A number two (2) next to the arrow is used to indicate the repeated part while a number one (1) is next to the original. An example of this is seen in Fig. 7 (VI).

The record described has been replotted in Fig. 7 (I) with the recovery points omitted and the blurs and breaks connected by line seg-

ments. All of the graphs in Figs. 7-10 with the exception of Fig. 9 (VII) have been plotted in this way.

In some of the cases an attempt was made to determine the phorias

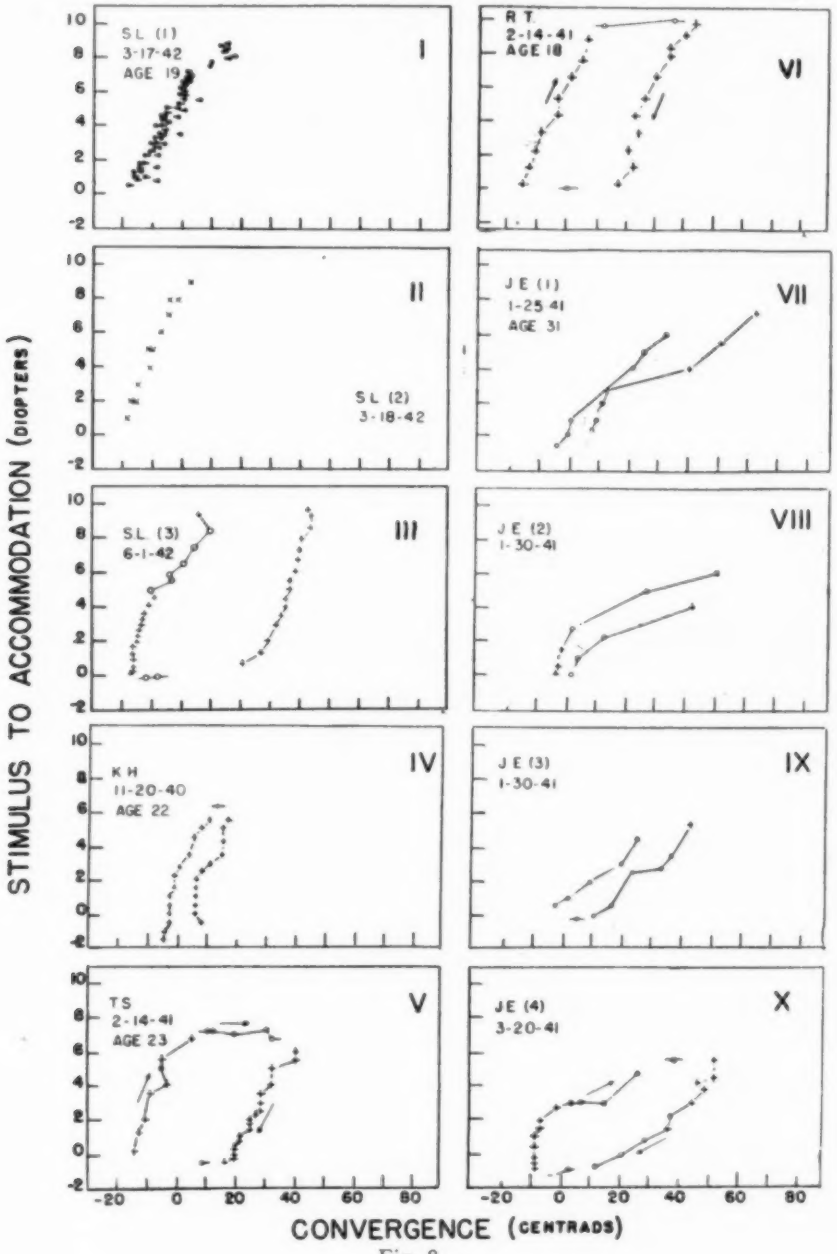

Fig. 8.

for various amounts of stimulus to accommodation. This was done by adjusting the mirror M′ so that the right target T′ was seen sufficiently higher than the left eye target T to prevent fusion. While the subject kept the letters of the lower target clear the haploscopic convergence was varied until the higher target was seen directly above the lower target. This setting gave a phoria reading for the stimulus to accommodation provided and was recorded on the graph as an *X*.

The exception noted above was obtained by means of the haploscopic arrangement shown in Fig. 6A. The difference between this arrangement and that of Fig. 6B is the addition of the accommodation measuring device (A) on the left arm of the haploscope. The fixation target *T* is mounted at 90° from its original position but its virtual image in the transparent mirror M″ is in the original position of the target and so continues to provide a stimulus to accommodation equal to that provided by T′ as well as a stimulus to convergence by its identity to T′.

The front end of the accommodation measuring apparatus (A) has a black surface with a narrow vertical slit through its center. This device projects two narrow beams of light through the pupil of the subject's left eye, the light from the upper half of the slit forming a narrow beam which passes through the temporal side of the pupil and the light from the lower half of the slit forming a second narrow beam which passes through the nasal side of the pupil. When the vertical slit at the front of the device *A* appears unbroken it lies at the conjugate focus of the retina, and the dioptric value of the accommodation is indicated by the tracing pencil at R. This, of course, measures the accommodation in the horizontal meridian only.

The device is movable along the axis represented by the dashed line independent of the movements of the mirror M″ and the virtual image of T along the same axis. A rotating knob operated by the subject controls the distance of the device from M″. Then, when the three sources of illumination, S. S′ and S″ are turned on and the haploscope is adjusted to permit fusion of T and T′ the subject sees a single target of letters with the image of the front surface of *A* superimposed. The slit at the front surface of *A* may appear either as a single full-length vertical slit or as a pair of half-length vertical slits, one in the lower half of the field displaced slightly to one side and one in the upper half displaced slightly to the other side. If the latter is seen the subject adjusts the knob while he fixates the letters until the two halves of the slit are aligned, making a single long slit. When this setting is obtained the

pencil at R indicates on the graph paper the amount of accommodation in play. The pencil at the same time shows the amount of stimulus to convergence. The stimulus to accommodation is indicated by a separate

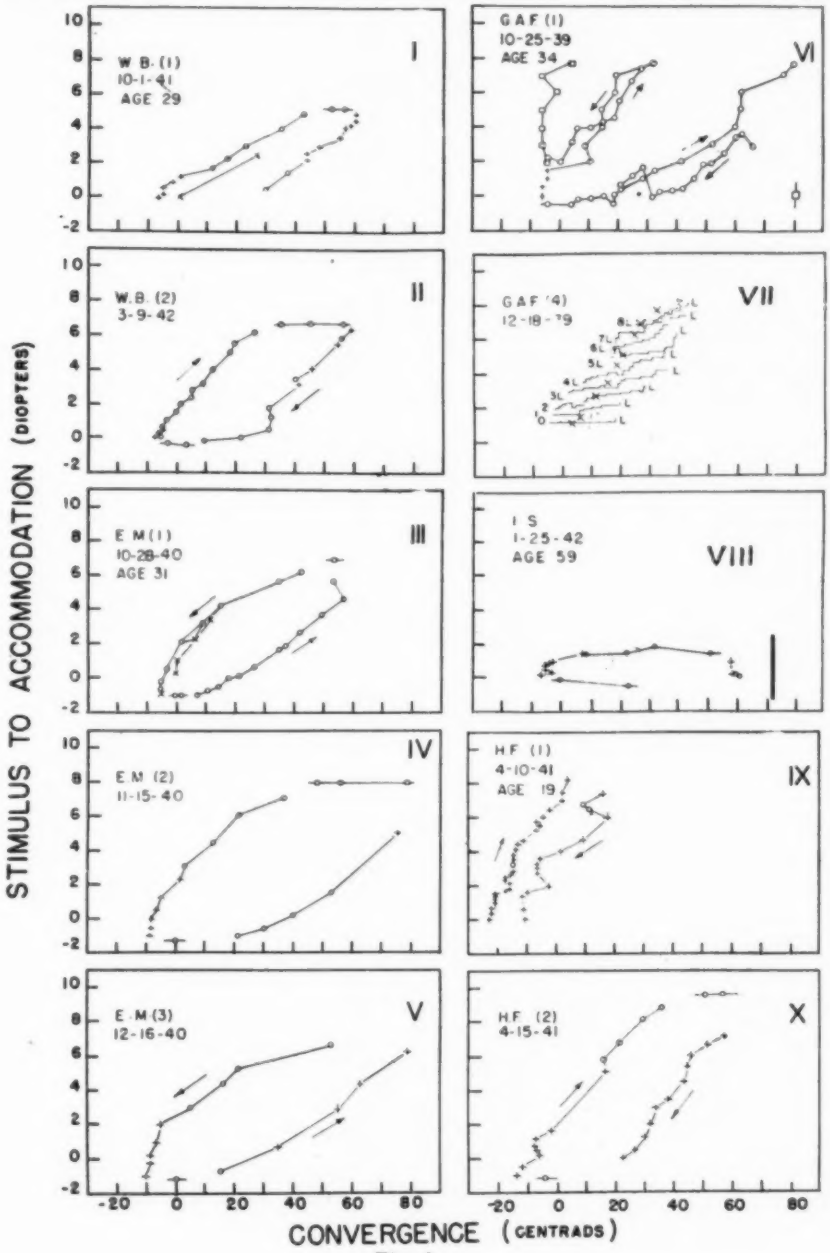

Fig. 9.

pointer attached to the mirror M'', or it can be read from a scale along which T' moves.

The special feature of this arrangement is that one can obtain a pencil tracing of the actual accommodative changes taking place while the stimulus to accommodation is fixed at some arbitrary value and the convergence is changing at the rate of 30 centrads per minute. This is what has been done in Fig. 9 (VII).

Although this graph is included in the various figures along with other graphs the meaning of the ordinate is not the same. The diopter values of the ordinate in the group now being described refers to the actual accommodation in play while in all of the other graphs the ordinate refers to the dioptric value of the stimulus. Hence, the exception to the title "Stimulus to accommodation" must be made in this graph in which the actual accommodation was measured.

As is indicated in Fig. 9 (VII), the records obtained in this manner show that the accommodation is by no means static when the convergence is changing, even though the stimulus to accommodation is constant for any one tracing.

The procedure by which this record was obtained is as follows: The stimulus to accommodation was first set at zero and the convergence set at some arbitrary value at which fusion could be obtained. The subject in this case was slightly myopic and slightly astigmatic and consequently saw the letters slightly blurred. While fixating these "blurred" letters he adjusted the knob which lined up the slits and so indicated that the dioptric value of the distance for which he was accommodating was one diopter. This measurement, however, represents only the horizontal meridian of the left eye and is therefore not to be taken as a value representative of the eye as a whole.

When the stimulus to convergence was slowly decreased to the point at which diplopia occurred the subject found it unnecessary to readjust the knob, indicating that the accommodation remained constant. The stimulus to convergence was then returned to the original starting point. With the slits still in alignment the convergence stimulus was slowly increased. The subject found it unnecessary to turn the knob until about 19 centrads were reached. The direction in which he found it necessary to turn the knob to keep the slits in alignment indicated that the accommodation started to increase. Mechanical limitations prevented further measurements with increased convergence.

The pencil tracing made during the procedure so far described is the bottom straight line in the figure. The line shows that no measurable change in accommodation took place between the limits of —6 and +19

centrads. At —6 a diplopia occurred; at +19 the accommodation started to increase. The L indicates that the instrument had reached its limit and the zero (0) indicates that the stimulus to accommodation was zero for this tracing.

The same procedure was repeated for a stimulus to accommodation of one diopter, two, etc., as indicated by the numbers of the tracings. An L at the end of a tracing means that the limit of the instrument was reached. The absence of an L indicated that a diplopia occurred.

The knob adjustments were usually made in quick jerks because it was easier to judge which way to turn the knob if it were held still for a few seconds until the direction of relative displacement was ascertained. A quick realignment of the slits then gave a stair-step pattern in the tracing.

The attention that had to be given to the slit alignment made it very difficult for the subject to make certain that he was keeping the letters clear. This, of course, had no significance so far as the measurements were concerned, since the stimulus to accommodation represented only a means of making the eyes accommodate and not a measure of accommodation. It can be seen, for example, that practically no more accommodation was induced by the 8 diopter stimulus than by the 7 diopter stimulus; the subject reported great difficulty in reading the letters when they were placed at 8 diopters. In spite of these difficulties the subject was able to report that a blurring of the letters was invariably observed at the moment when he found it necessary to make very rapid adjustments of the knob.

The X's represent simultaneous measurements of the phoria and of the states of accommodation for the various amounts of stimulus to accommodation employed in obtaining the tracings. These measurements were made by adjusting the mirror before the right eye so that the image seen by the right eye would be higher than that seen by the left. With the stimulus to accommodation set at various amounts and the subject continuously keeping the slits aligned by means of the knob control, the haploscopic convergence was adjusted until the subject reported the right eye target to be directly above the left eye target. Such a setting is represented by an X.

Most of the subjects on whom these various tests were made were patients from the eye clinic of the Ohio State University School of Optometry. The rest of them were members of the staff or students in the School of Optometry who submitted themselves voluntarily as experimental subjects.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Established 1924

Vol. 22 JULY, 1945 No. 7

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Annual Subscription, $5.00 in Advance; Canada, $5.50; Foreign, $6.00;
Single Copies, 50c.

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Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

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ACADEMY ASSISTS RESEARCH PROJECTS

One of the objects of the Academy is the initiating and supporting, in suitable centers and institutions, of research projects in optometric subjects. In line with this program the Academy has from time to time made designations of its funds to assist in the financing of properly made investigations in the field of visual science.

This year, in accordance with this program and upon action of the Research Projects Committee, the Executive Council has approved an appropriation of five hundred dollars, made to the University of California, School of Optometry, for use by Dr. Meredith W. Morgan

Instructor in Optometry, to assist him in carrying on special research studies in the following fields:

(1) An Investigation of Techniques Employing Stereoscopic Targets for Orthoptic Treatment of Binocular Anomalies.

(2) Investigation of the Direction and Final Resting Place of the Visual Axis When Fusion is Broken as in Duction and Fusional Reserve Tests.

(3) Investigation of the Langworthy and Gelhorn Theories of Pupillary Dilation.

The only conditions surrounding this grant of funds to Dr. Morgan are that the work be completed within a year, or as near thereto as possible, and that papers or reports be submitted for publication in the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY with the footnote to the effect that the research was aided by a grant from the American Academy of Optometry.

The Academy considers it a privilege to assist Dr. Morgan in the continuance of his work in the field of visual research. Dr. Morgan and his associates at the University of California have already made valued contributions to our sum of knowledge and we look forward to their further efforts.

The Academy has additional earmarked funds which may also be used in this manner. Dr. Robert E. Bannon[1], Chairman of the Research Projects Committee of the Academy recently announced that optometrists and others interested in working on problems of visual research should contact the Academy with the thought in mind of making similar arrangements.

CAREL C. KOCH

EDITOR'S NOTE: The Editorial Council of the American Academy of Optometry express their appreciation to the Distinguished Service Foundation of Optometry for the permission to publish the Hofstetter treatise on binocular vision, Part I of which appears on pages 301-333 of this issue.

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[1]Robert E. Bannon. American Academy of Optometry Research Projects. Amer. Jour. Optom. & Arch. Amer. Acad. Optom. 22. 6. 281. 1945.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news professional problems and ideals, as these relate to the Academy.

MARYLAND CHAPTER

A special meeting of Maryland members of the American Academy of Optometry was recently called by acting chairman, Dr. Israel Dvorine. This meeting was held at the Lord Baltimore Hotel, Baltimore, Md. The purpose of the meeting was to organize a chapter of the American Academy of Optometry in the state of Maryland.

After explanatory remarks pertaining to the purpose of this meeting, Dr. Dvorine introduced Dr. J. Fred Andreae, President of the American Academy of Optometry, as the speaker of the afternoon. Dr. Andreae explained the requirements for an optometrist to become a member of the American Academy of Optometry as well as to become a member of a chapter of the Academy. His discussion also explained the necessary steps in organizing a chapter in the state of Maryland. It was also pointed out that eligible optometrists from neighboring states could join this chapter if they so desired.

ALTON G. BILLMEIER

LOS ANGELES CHAPTER

Meeting held, May 11, 1945. Fellows present were: Hutchinson, Hoare, Dean, McBurney, Fuog, Winslow, Deacon, Weigmann, Apel, Wright, Ketchum and Goodman. Guests were: Dr. B. I. Hansen, also the following members of the California State Board—Mr. R. E. Flower from Visalia and Dr. Fred W. Pottle from Oakland. Also Mr. J. E. Tufft, Editor of the WESTERN OPTICAL WORLD, and Mr. Rohn from the Attorney General's Office.

Following dinner and out of respect to the passing of Franklin D. Roosevelt, Fellow Hutchinson read Robert Louis Stevenson's "Requiem". President Hutchinson then called on Vice-President Hoare to act as Chairman of the Education Section. Fellow Harry Goodman presented his paper on "Trends in the Practice of Optometry". Drawing on his vast experience of years as a member of the State Board of Optometry he sketched the high-lights and trends in economics. Fellow Goodman recommended that optometry retain and continue to dispense its own

prescriptions. He recommended further legislation for the protection of the profession. After appropriate remarks by Chairman Hoare, Fellow Harry Fuog presented "Trends in the Science of Optometry." The speaker admonished us to be ever alert to attain better understanding of our findings.

After a short recess, Fellow Ernest Hutchinson presented, "Trends in Optometric Education". He first read and discussed a recent letter of Dr. Charles Sheard's to Dr. Wheelock—then president of the Academy—dated December 9, 1944. He discussed improvement of the Optometric School and the idea of affiliation with Universities having medical schools.

After general discussion of these papers, Mr. Rohn, of the Attorney Generals Office, expressed an opinion as to the enforcing of our State Laws. Drs. Flower and Pottle spoke informally as members of the Board, stating their attitudes toward violations. Fellow Hoare then turned the gavel back to President Hutchinson.

A motion was made and passed that the President be empowered to appoint a committee to investigate the action of the National Body relative to the recommendations of Dr. Sheard and report. That this committee also be requested to bring in recommendations.

JOHN R. DEAN

CUYAHOGA ACADEMY OF OPTOMETRY

The following objectives have been approved for the Cuyahoga Academy: (1) To prepare the way for our returning optometrists from this area to set up *successful* professional practices. (2) To take the initiative in bringing to Optometry the recognition of which it is deserving. (a) By exemplary private practice. (b) By participation or representation in all activities concerning eye care of a civic or charitable nature. (3) To achieve the scientific contributions to which our Academy is dedicated. (4) To make our Academy function so as to inspire the deep interest of all of our professional men.

We believe that more than words and hopes are necessary to keep the returning servicemen from commercial establishments. We make no pretense at being unselfish in aiding servicemen to establish themselves as professional men since we view failure to do this as catastrophic. Yet we feel our full responsibility to them as individuals who have sacrificed in our place.

To facilitate this activity our plans include:

1. The Post-War Planning committee which has already functioned in setting up expert guidance as well as practical help. (Dr. W. P. Kramer, Chairman will report on this in the near future.)

2. The Committee on Industrial Vision — the establishment of panels for industrial refracting and the inclusion of our veterans will assure them of practical aid in the early and tough stage of setting up their private practices.

3. The special Committee investigating the establishment of an Optometric clinic. Such a clinic would serve as a refresher in affording returning men to work alongside experienced practitioners as well as a source of income.

4. The Public Relations Committee hopes to make further opportunities available through its contacts with the schools, traffic department, etc.

We have felt that these activities help in the achievement of our other goals since they necessarily involve an increase in optometric prestige and since they demand the unity of action required to insure a strong well-knit organization.

Absorption in these goals has strengthened our group. Attendance has been close to 100% at each meeting despite a 75 mile membership radius. We have had stimulating and outspoken discussion which has been of benefit to all of us.

The scientific portions of our program have been highlighted by the excellent speakers secured by program chairman Carl Radde each month. In addition, fellows have been encouraged to engage in original research or formal presentation of clinical data. R. S. JORDAN

IOWA ACADEMY

At a meeting of the Iowa Academy of Optometry held in Des Moines, Iowa, Thursday, May 24th, Dr. George Warkentine of Cedar Rapids was elected President, Dr. M. P. Gleason of Centerville, Vice President, and Dr. J. J. Brady of Sheldon, Secretary-Treasurer. The morning was devoted to conduct of business and in the afternoon, several technical papers were presented.

Those present were: Dr. Dawson E. Grimm, Cedar Rapids; Dr. Louis W. Palm, Kansas City; Dr. John R. Lee, Guthrie Center; Dr. L. C. Holman, Cedar Falls; Dr. Dwight E. Hook, Des Moines; Dr. Alfred A. Haimaum, Oskaloosa; Dr. V. V. Kirby, Des Moines; Dr. Howard A. Pierce, Storm Lake; Dr. George J. Ronan, Des Moines; Dr. Ralph J. Hays, Harlan; Dr. Geo. H. Warkentine, Cedar Rapids; Dr. John J. Brady, Sheldon; Dr. Richard C. Schiller, Marshalltown; Dr. L. Hoefle, Orange City; Dr. E. G. Danner, Chariton; Dr. P. Gleason, Centerville; Dr. E. W. Martin, Carroll; Dr. A. P. Wheelock, Des Moines; Dr. J. P. Cunningham, Des Moines.

J. J. BRADY

SPECIAL REPORT

ETHICAL AND PROFESSIONAL OPTOMETRY IN IOWA*

G. H. Warkentine, O.D., F.A.A.O.

Cedar Rapids, Iowa

Optometry today is, perhaps, in the middle of the greatest mutation that has ever been experienced in this new—yet old— calling. It is beginning to feel—with full force—the energy exerted from within,—that will cause a change in appearances, in interpretation by other professions, in the public concept, in education, and in the very definition of the word—optometry. This force has been brought about because the turning point has been reached in the mind of the public as to proper eye care, and this grand profession *must not* resist this change. We *must* accept it fully; this mutation *must* take place. For, if we *do* resist—*do* refuse to yield to this force—the effect will be one that will produce the extinction of our profession—just as surely as nature will heartlessly cause the elimination of one of her species of animal or vegetable life that does not, or cannot adapt to a change in environment.

The handwriting is on the wall, and it is merely for us to translate —if we will. This message, briefly stated is: "The day of the spectacle salesman is gone." The realization that visual care is not an incidental, but rather, an important part of the healing arts is now well known to all professional men. The acknowledgment of this realization is forced by the great advancement in eye care brought about by the study and research of many men in optometry as well as the activities of eye specialists in other professions. Optometric education acknowledges this high place to visual care, and our courses offered today are technical ones that equip graduates for professional practice. Yet, in the face of all of these facts, we find that by far the greater share of our fellow practitioners have not yet realized this startling and important condition. We have not yet met this change within us—as a body. If we do not elevate the optometry we practice to the point where it can be accepted as a professional group—by having the greater share of us practicing in a professional and ethical manner—then our claim to visual care will

*An abridgement of the material presented at the meeting of the Iowa Chapter, American Academy of Optometry, Des Moines, Iowa, May 24, 1945. For publication in the July, 1945 issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

become overshadowed and superseded by an affiliate of another profession that *will* take care of the job in the manner that we should.

Just what is our composition? We are today a very heterogeneous group. We are made up of many different types of men, and many different types of establishments. As a whole, we speak many different languages. We have within us an element that seems to feel justified in keeping alive certain business organizations that do nothing in the transaction of their business but cast shame upon us. We also have that type individual who has no better standards than those commercial ones just mentioned, but conducts his business for himself rather than for a business firm or corporation. Then we have those that have ambitions to be in a higher plane of practice than commercialism, and no doubt are capable men, but for some reason or other lack the courage to make the move to more professional surroundings that would be consistent with the accepted standards of professional practice established by other practitioners of the healing arts in their community. Finally, we have the group in which I believe we find ourselves—that group made up of those of us who have felt the call of professionalism, and made the effort to conform. I make this last statement with no attempt to develop within you a feeling of superiority, or to attempt to influence you to conduct yourselves in an ungentlemanly manner in your association with others in our profession who do not practice as you do. I merely make this differentiation because it is a fact, and you do practice professionally. You carry the same license as do all optometrists in Iowa, your educational background may, or may not be the same as other optometrists, *but*—you do not practice your profession the same—and this fact alone makes you, as a group, different. You keep your house clean while others do not, and I feel that you should have pride in this mark of distinction. Perhaps by your good example, and with a little effort on your part, you may be of some influence to others in getting them to clean up their house too, and if you are—even though the cases are few, —the people of the community affected, and humanity as a whole are benefited.

In the analysis of our present condition, we come to the natural question as to what to do about it if this condition must be changed. The answer to this question is not very hard. Those who can qualify to professional standards should band themselves together. After this movement has been started and accepted, the organization should make every effort possible to find out just who the men are that are in optometry, and can qualify for an organization of this kind. After this list is

compiled, all of us should be willing to devote some time and effort to contact those men in our community or nearby towns, in an endeavor to get them to affiliate to the Iowa Academy. There must be, of necessity, certain restrictions to membership, but such restrictions can be decided upon by a meeting of this kind. It is entirely possible that many men in Iowa today would be interested in this Academy, and the only effort needed to induce them to join us would be to investigate their qualifications, and if found compatible to our ideals, invite them to join, after explaining our cause. I cannot help but feel that by these few simple steps we would be able to build a group of men in this state that would be accepted as the representatives of professional ideals in optometry.

The idea of chapters to the American Academy, such as this one will be, is not new. There are several throughout the country that have established themselves as shining examples of professional thought, from which we can well take instruction. One of the outstanding examples of associations of this nature is the Los Angeles Chapter of the American Academy. In the April issue of the Archives of the American Academy, there is a paper by Dr. Ernest A. Hutchinson of the Los Angeles Chapter, under the title of "Mobilizing the Forces of Ethical Professional Optometry." The entire paper is well worth the reading, as are quite a few other articles in this issue pertaining to the subject, but I consider the following parts of Dr. Huchinson's paper to be important enough to us to mention them at this time. I quote:

"This is a call to arms—just as imperative to the future of our profession as is the service of your boy and mine to the country we love—and to the other freedom loving or seeking countries the world around. Nothing worth while ever was achieved by sitting around waiting for something to happen . . . The next five years well may determine the future of optometry for years to come—or for all time . . . Optometry's future is in the hands of the American public. Academy standards are the ultimate guarantee of that future. Socialized health care is here for many millions in the armed forces and their dependents. Much more is on the way. It is not an attempt of politicians to regiment anyone—it is the result of an irresistible pressure. Widespread legislation is imminent. We cannot conceive that advertising physicians, dentists or commercial spectacle venders will have any place in the new scheme of things. Unfortunately our local, state and national optometric associations have not been sufficiently discriminating to put the mantle of professional virtue upon the shoulders of their heterogeneous membership. It is a tragic situation—but it is useless to ignore facts,—unpleasant though they may be. A higher standard is essential and urgent. The Academy offers that standard,—but the Academy lacks numbers sufficient to command respectful attention. The conclusion is inescapable. We must greatly increase our numbers and do it quickly. There must be no letting down of standards to achieve this result. Along with it must go Herculean efforts to raise the entire level of optometric standards and practice. There can be no half measures. We must make Fellowship in the Academy a mark of distinction, sought and prized by the best men and women in our profession.

"Obviously this requires a new orientation. It cannot possibly achieve the desired vitality and influence if it is to remain largely a passive organization consisting essentially of a few officers, however devoted, who correspond voluminously during the

year and annually meet for two or three days to hear and read papers and elect officers. All these things are excellent in themselves.—but insufficient. The only solution to this urgent problem is widespread organization of local chapters—active chapters. Active educationally—constantly striving to elevate the Fellows by bringing in recognized authorities in allied fields; medicine, physiology, psychology, parasitology, education, physics, sociology, etc.

"All present members of the Academy are urged to get together a small group of the most ethical, most influential of their professional colleagues and impress upon them the urgency, the opportunity, and the high privilege of leadership in a movement to guarantee the future of our profession as an instrument of bringing to humanity a service of real merit. Together let us work and plan that the very mention of optometry shall arouse feelings of gratitude and satisfaction."

In concluding, Dr. Hutchinson lists some values in maintaining a chapter to the American Academy such as the Iowa Chapter will be. They are:

1. It is a necessary and valuable channel through which shall flow a constant stream of influence for the upbuilding of the highest quality of ethical and technical skill among the practitioners of optometry.

2. Serving this purpose will be scientific papers of real worth delivered in person by leaders in optometry and in related fields of medicine, physiology, psychology, education, etc.

3. The reflex effect upon these leaders—of contact with a group of highly intelligent, ethical practitioners of optometry and with leaders of scientific thought in optometry.

4. The benefit accruing to our own Fellows as they prepare and present papers—and the broadened culture resulting from continuance of such regular programs.

5. The opportunity of the bringing into our meetings of key personnel as guests—notably those who are opinion molders; university faculty members and administrators, physicians in good standing with their own group and others who for one reason or another might be interested in the program presented.

6. The privilege of meeting in an organization which concerns itself solely with cultural values and not at all with fees and economics which have their place—but not in an academy.

7. Add your own concept of values to be achieved, one of which probably will be the reflex effect upon the entire profession.

I feel that this article contains a wealth of material that can be of extreme value to us in shaping our plans for organization and future activity. I feel that it points out the need in optometry, and a solution whereby we may be able to meet the changes that are happening—and must happen—if we are to retain our identity. In regard to Dr. Hutchinson's reference to socialized medicine or public health, this question may or may not arouse in some of you the feeling that it is a debatable issue. If this should happen to be the case, I offer no opposition to such thought, since my information as to this national leaning is extremely limited and of no authoritative background. I do feel, however, that if it should come to this nation, there is no possible chance for the survival of anyone in optometry who does not practice his profession according to the standards set up by this Academy.

These statements may be interpreted by some of you as an indication that I favor the establishment of an Academy Chapter in Iowa to take the place of the State Association. If so, I wish to make myself clear now. I heartily endorse the Iowa State Optometric Association, and am myself a member, through my own desires, and not because of any existing laws. I am a member because of a firm conviction that a strong state and national optometric association is a very desirable thing. Laws should not be necessary to promote membership in such a group because it is inevitable that all professions band themselves together in such a manner so as to protect their business interests, formulate their laws, advise on economics, assist in placement of graduate students, etc. But—when I make these aforementioned statements, I speak in favor of the Academy idea because the Academy idea is entirely separated from any conflictive idea in a state or national association. Webster defines the word Academy, as: "A society of learned men, united to advance art or science." This is short, and to the point. This is exactly what we believe our objectives are; this is exactly what we believe this group will become. We intend to devote our thought and energies to advancing our own "art, or science" in the best way possible for us to do so.

Let us discuss optometric education as it is today, for a while. We are practicing a profession that is a science, and anyone who is familiar with the curriculum of any of our modern colleges of optometry which qualify as Class A schools knows well enough that we need have no feeling of inferiority with reference to the educational background of our new graduates. The complete cessation of war—and we hope it is not too far distant—will enable our country to gradually resume its normal way of living, and our colleges will then be able to return to the healthy condition they were in before hostilities began. The result of this will be that the years to come will produce young blood in our profession in ever increasing numbers, of whom we can well feel proud. Yes, our educational institutions will produce men of learning, well founded in all of the basic sciences, which include those of mathematics, biology in all of its branches, physiology, pathology, physics, chemistry, psychology, the optical and ocular specializations of all of these fundamentals; the arts of humanities, English, ethics, professionalism and many others. Good experience obtained in established clinics in which thousands of cases of all types are encountered each year, make our newcomers equal to the task before them. Furthermore, for all I know, the optometric courses of the future may become even more efficient than they are now. Nevertheless, and irrespective of future development in our educational

institutions, there is no question but what the mutation which was mentioned before *has* been experienced in our schools. They are no longer institutions in which mere attendance is all that is necessary for graduation. The student must prove himself capable or he is eliminated. A graduate of our approved colleges today is a highly trained visual specialist who has encountered more education pertaining to visual problems of man, in all of its variations, than that of any other profession. This is so, regardless of the recent opinion of Secretary of War, Stimson, and contrary to it.

How does all of this affect us, and why are we concerned with the education of our newcomers? It is because the steady flow of men of this caliber into our ranks will give us assurance that they will not, as a whole, be willing to place themselves for hire to all of the many pitfalls that are encountered by the new graduate. Our new men will know from the training they have had that their qualifications are far above the sordid appeal of commercial inducements. They will feel that they will not be willing to spend the balance of their life in perpetuating and nurturing business houses that cannot possibly have any claim on this profession. They will be so highly capable in their work, and so well founded in the ways of professionalism, that they will not be able to feel satisfied in practicing their profession in any other way than that in which they can feel the greatest amount of pride. We then, will acquire professional men in our newcomers, and we must be prepared to welcome them as such. Of course they will want to join the state and national associations, but they will also be anxious to affiliate with the type organization we are today forming. It is for us then to prepare the way for them; to have just such societies as this functioning well, so that all that will be necessary will be to offer the newcomer membership, after qualification—and he will become one of us—and we will fulfill his desires for professional associations. We will find that our efforts will not be in vain and we will have an increasing demand for the Academy idea as time goes on. Our schools will give us the men that we need, and we must be prepared to accept them.

This, then, is one reason why we must professionalize. The others were mentioned at the beginning of this paper. To review them briefly, we must professionalize because public concept of proper eye care has been changed, and we must conform to it. We must professionalize because if we do not provide eye care that is consistent with the highest standards, we will be replaced by others of another profession who will. We must professionalize in anticipation of the advent of socialized

medicine, for if it comes we will not be accepted unless we are. Last and not previously mentioned, we must professionalize because of our own desire to have pride in our work, pride in our colleagues, pride in our accomplishments, and respect in the eyes of our fellow man.

The means to this honorable ending is the determined formation of groups such as ours—active groups that will preach the gospel of professionalism throughout our ranks, and increase our numbers; that will do the work before us so thoroughly that the optometric definition of the word Academy can be stated as: An optometric Academy is a society of learned men, united to advance the art and science of optometry, and by practice to establish this science in the minds of all people as being one of honor, respect, dignity, competence and true professionalism.

ANNOUNCEMENTS

OHIO STATE UNIVERSITY—OPTOMETRIC DEVELOPMENT PROGRAM

The Optometric Development Program of the Ohio State University, School of Optometry, has recently been organized. This new group has been created to assist the Sheard Foundation for Research in Vision. Optometrists are requested to contribute to and join the Optometric Development Program of the Ohio State University. Its newly adopted Constitution follows:

CONSTITUTION OF THE OPTOMETRIC DEVELOPMENT PROGRAM

ARTICLE I—NAME

The name of this organization shall be the Optometric Development Program at the Ohio State University.

ARTICLE II—OBJECT

The purpose of this organization is to raise funds from optometrists and others interested:

(A) To aid in the establishment and support of the Sheard Foundation for Research in Vision which will be an integral part of the Graduate School and which will be devoted to research concerned with the fundamentals of vision and their application, the training of teachers and research workers on the post-graduate level to serve the professions and industries concerned with vision, and to assist in the development of a leadership in visual education and practice in the public interest.

(B) To aid in the development of an outstanding center of optometric education and research at The Ohio State University, through the erection of a new Optometry Building to house enlarged and improved educational, clinical and research facilities.

ARTICLE III—MEMBERSHIP

Two classes of members are provided for in this organization.

(A) Contributing Members—individuals who contribute one hundred dollars or more over a period of five years or less through this organization for the development of education and research in vision at The Ohio State University.

(B) Sustaining Members—individuals who contribute five hundred dollars or more over a period of five years or less through this organization for the development of education and research at The Ohio State University.

ARTICLE IV—THE STANDING COMMITTEE

Section 1. The governing and directing body of this organization shall be the Standing Committee.

Section 2. Members of the Standing Committee are as follows:

Dr. Emil Arnold, Ann Arbor, Michigan
Dr. Joseph M. Babcock, Portsmouth, Ohio
Dr. B. M. Covert, Athens, Ohio
Dr. H. Ward Ewalt, Jr., Pittsburgh, Pa.
Dr. Glenn A. Fry, Columbus, Ohio
Dr. Richard M. Hall, Cleveland, Ohio
Dr. P. C. Harris, Columbus, Ohio
Mr. D. D. Hubbell, Columbus, Ohio
Dr. Gustave Ohlsson, Detroit, Michigan
Dr. Alpheus W. Smith, Columbus, Ohio
Dr. F. A. Stengel, Marion, Ohio
Dr. H. Lynn Wade, Springfield, Ohio
The President and Secretary of the Ohio State Optometric Association.
The President and Secretary of Ohio State Board of Optometry.
The President and Secretary of Ohio State Alumni of Optometry.

Section 3. Vacancies which arise on this committee shall be filled by a majority vote of the members of the committee.

Section 4. All officers shall be members in good standing of the Standing Committee and shall consist of a chairman, secretary and treasurer.

Section 5. Duties of officers:

(A) The chairman shall preside at all meetings of the committee and shall be an ex-officio member of all committees. He shall have power to call meetings of the committee when deemed advisable.

(B) The secretary shall record all minutes of the committee meetings and shall send out notices of all meetings. He shall be an ex-officio member of all committees.

Section 6. The Standing Committee shall meet at least once each year. There shall be such other meetings each year as the chairman with the approval of at least two other members of the committee, may deem desirable. A meeting shall be called, likewise, by any other officer upon the request of four members of the committee.

Section 7. Election of officers.

All officers shall be elected at the annual meetings and shall hold office until their successors have been elected. Any officer may be removed from office by a two-thirds vote of the members of the committee.

ARTICLE V—EXECUTIVE COMMITTEE

Section 1. For purposes of administration there shall be an Executive Committee. It shall comprise the Dean of the Graduate School, the Head of the School of Optometry, the Executive Secretary, the Treasurer of the Ohio State University Development Fund, and the Chairman of the Standing Committee.

Section 2. Duties of the Executive Committee:

(A) Supervise the raising of funds.

(B) Carry out the policies of the Standing Committee in connection with the expenditures of the funds.

(C) Employ an Executive Secretary and other such help as may be necessary from time to time.

ARTICLE VI—ADMINISTRATION OF FUNDS

Section 1. All contributions obtained by the Standing Committee or its agents other than contributions for operating expenses of the Committee are to be made through the Development Fund to the Board of Trustees of The Ohio State University, and must be used in accordance with the purpose designated by the donor. Undesignated gifts shall be expended at the discretion of the Executive Committee defined in Article V.

Section 2. A special fund for operating expenses of the Standing Committee shall be raised. All contributions made for this purpose shall be paid to the Development Fund, and shall be kept separate from all other funds.

Section 3. Salaries and operating expenses shall be paid from this operating fund only in accordance with a budget formally adopted by the Standing Committee.

Section 4. Funds may be used for operating expenses only when designated for this purpose by the donor.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics
12. Miscellaneous.

11. EDUCATION, SOCIOLOGY AND ECONOMICS

PROGRESS MADE IN CARING FOR VISION OF BRITISH WAR WORKERS. C. H. Sadler. Optical World. 1944, 32, 8, 34-36.

Sadler has worked as a refractionist in several clinics attached to British industry. He believes that the work of the optometrist should include the study of visual environment and working conditions and that this can best be achieved when he is attached to the health service unit in such plant. He further believes that this is an essential part of our post-war development in optometry. C.C.K.

DUTIES AND TRAINING OF AN ORTHOPTIC TECHNICIAN.

W. B. Lancaster. American Journal of Ophthalmology. May, 1944.

Lancaster attempts to define the respective spheres of the ophthalmologist and orthoptist working together. It is the ophthalmologist's duty to make the diagnosis and plan to supervise the treatment. He should report to the orthoptist, ophthalmoscopic findings, visual acuity, refraction, deviations, history; then the orthoptist further diagnoses the case from the standpoint of intelligence and co-operative ability of the patient, and handles the details of orthoptic training. Lancaster discusses the question of relationship between the two co-workers.

The orthoptist's best pre-training background is, according to Lancaster, perhaps teaching or work in psychology, since psychological and educational aspects are vital in orthoptics. Some anatomy is necessary; full knowledge of physiology, physiological optics and psychology is important; but one need not have thorough grounding in optometry or medicine.

C. C. K.

THE INDUSTRIAL REFRACTIONIST.

R. M. Hall. Journal of the American Optometric Association. 1944, 15, 10, 295-299.

War time emergency has increased the need for the industrial refractionist, as it has for other professional people, and it is the duty and the responsibility of the professions to fill that need as adequately as the current manpower shortage will permit. Industry in general, says Hall, finds itself in need of an overall eye care program. A program which not only embraces those medical and surgical services attendant to hazardous occupations, but also one that provides practical, economic and time-saving methods for the determination and maintenance of visual efficiency as related to employment, classification and job placement. It finds itself faced with the problem of securing immediate eye protection for thousands upon thousands of employees; with securing professional eye care, ophthalmic materials and services attendant thereto from depleted, disorganized and disunited sources; with a need for greater cooperation and understanding of its needs by the professions; with the development and organization of certain socio-economic policies which, because of precedence or other reasons, may easily work economic hardship on it in the future. The professions, on the other hand, in the interest of industrial health and welfare, need first of all a rapprochement between themselves—an unselfish determination of their respective

spheres—their qualifications and responsibilities incident to the work to be done. They need, says Hall, to learn the ways, needs, and desires of industry and to revise their economic policies accordingly. They need the cooperation of industry, labor and the ophthalmic distributor to fully discharge their responsibilities to the employee. They need assurance by industry that the paternalistic trends of the present will not be used to break down their social and economic structure.

A. V. F.

VOCATIONAL TRAINING PROGRAM FOR THE VISUALLY HANDICAPPED IN THE MINNEAPOLIS PUBLIC SCHOOLS. K. F. Gruber. Sight-Saving Review. 1943, 13, 2, 104-117.

The vocational training program for the visually handicapped in the Minneapolis public schools is called Applied Industries. It was initiated in 1935. Prior to that time all visually handicapped pupils, upon graduation from high school or upon reaching the age of sixteen and no longer attending school, were clients of the State Department of Vocational Rehabilitation. They received their vocational adjustment through the Minneapolis representative of that Department.

Because of the lack of vocational opportunities suitable for the visually handicapped in the regular high schools, most of these pupils were graduated with a purely academic record. There was little or no available information concerning their vocational skills, interests, or aptitudes. It is needless to say that the majority of them became embarrassing responsibilities for the local rehabilitation office. It therefore became increasingly necessary, says Gruber, for the sight-saving department to give consideration to vocational education.

Vocational training while the pupil was still in high school offered a solution to a very complex problem. Consequently a plan was worked out with the curriculum department of the Minneapolis public schools whereby 12th grade visually handicapped pupils might receive two vocational credits each semester for fifteen hours per week of supervised training in industry, such credits to be applied toward high school graduation. A program was developed by which 12th grade pupils who chose applied industries as part of their last year of work in high school would be enrolled in an academic high school sight-saving class for half a day, and would be engaged in a supervised training program in industry the other half.

To implement this program, the sight-saving department selected

one of its qualified high school teachers to serve as vocational co-ordinator for the applied industries pupils. It was agreed, however, that the State Department of Vocational Rehabilitation through its state vocational counselor for the visually handicapped would assume further vocational adjustment of these visually handicapped pupils if, after graduation from high school, their employment problems were still unsolved.

In formulating plans for the student, the co-ordinator, says Gruber, must have in mind the following general policies governing the selection of training objectives as stated by the Minnesota Division of Rehabilitation in 1941: (1) It is basic to the theory of rehabilitation in the competitive economy of today that the handicapped person should be guided to the selection of training for an occupation in which he will be able to do work of quality and amount equal to that of the average worker having no physical handicap. (2). Training must in all cases have a definite vocational objective that can be attained within a reasonable time. (3). The training objective should be in harmony with the individual's abilities and physical condition. Sufficient evidence must be submitted to support the selection of the training objective. (4). The objective must be a legitimate, recognized occupation. (5). The objective must be one from which the client will not be barred by legal or other restrictions because of the type of his disability or inability to meet the established minimum requirements. (6). Training is most effective when it operates upon the principle of multipotentiality and versatility. That is, in the selection of training, the counselor should not overlook the advisability of preparing the individual so that he can adapt to many different jobs requiring similar skills. (7). It is required that the counselor, in selecting the type of training to be provided, will adhere to the principle of selecting such training as will prepare the client for employment in the shortest possible time and at the most economical cost consistent with adequate preparation. (8). Training that does not prepare specifically for a definite type of employment cannot be included. (9). Rather than establish arbitrary lengths of training periods for each employment objective, each training program should allow a period of sufficient length to provide adequate preparation for the employment objective selected. Long, drawn-out periods of training which defer entrance into remunerative employment should be avoided and discouraged. The counselor is expected to determine the length of the training period and to make recommendations accordingly.

C. C. K.

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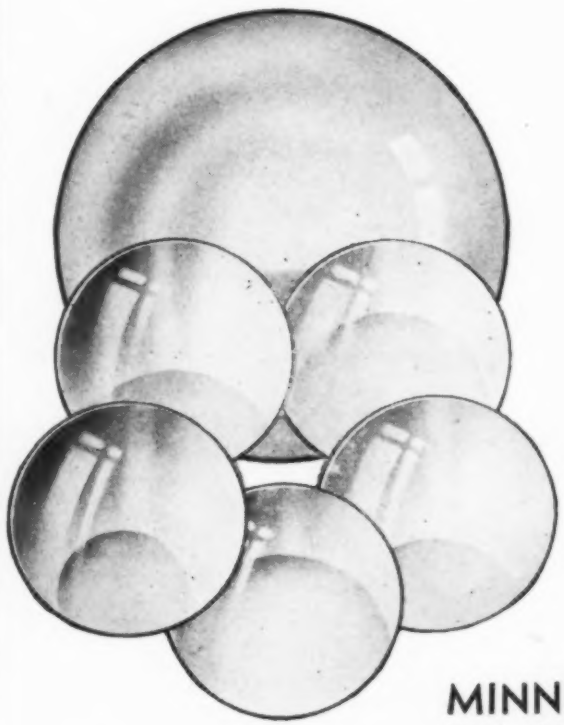

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